This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

BRANNER
GEOLOGICAL LIBRARY

STANFORD UNIVERSITY
LIBRARIES

THE GEOLOGIST;

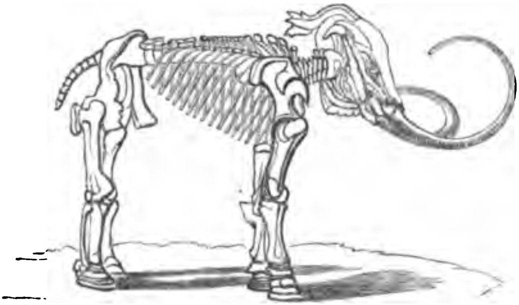
A POPULAR ILLUSTRATED

MONTHLY MAGAZINE

OF

GEOLOGY.

EDITED BY S. J. MACKIE, F.G.S., F.S.A.



STANFORD LIBRARY

LONDON:
"GEOLOGIST" OFFICE, 154, STRAND.

1859.

210722

PRINTED AT THE "GEOLOGIST" OFFICE, 154, STRAND, LONDON.

PREFACE.

ONCE more all the world is preparing for that most jovial of all jovial seasons, when the workman lays down his tools, the clerk forsakes his desk, the merchant his counting-house; and authors and editors rejoice, like other people. Poor, indeed, must he be both in pocket and heart who cannot afford a day's holiday and a good dinner on "Merry Christmas." For the second time we, too, abandon our monthly labours. We have prepared our Index, made up our Volume, bound it in its cover of purple and gold, despatched it far and near over the British isles and abroad, even to the confines of America and India; and now, for the second time, in all sincerity and earnestness, we wish our Friends and Readers a "Merry Christmas, and a happy New Year."

Again we have brought the good ship "GEOLOGIST" safely into port. Onwards we have steered our steady course, encouraged throughout by the kind words and appreciation of almost numberless friends. If the expressions of goodwill and laudation which have reached us from so many quarters could make us vain, we might print pages of authorities for our title to give loose to an easily-developed passion; but every word of praise will only make us more chary of an acquired reputation—more careful in what we do—more anxious to be ever and ever more worthy of patronage and support.

To my friend Mr. Davidson I have been indebted for a valuable paper on the Strophomenidæ and Productidæ, and the beautiful plates which accompany it. And in the closing pages of this volume we have commenced another extremely valuable contribution by the same hand on the Carboniferous Brachiopoda of Scotland, which will be accompanied by many equally beautiful plates.

To the Rev. W. S. Symonds, F.G.S., the Rev. T. Wiltshire, F.G.S., the Rev. Dr. Anderson, Dr. Phipson, Count Marschall, Mr. Bevan, Dr. G. D. Gibb, F.G.S., Professor Harkness, M. Jules Marcou, Messrs. H. C. Salmon, F.G.S., H. C. Sorby, F.R.S., F.G.S., Edw. Wood, F.G.S., W. Pengelly, F.G.S., Geo. Tate, G. E. Roberts, H. Mitchell, and the too long list of contributors for insertion here, my grateful thanks are due. And to my numerous friendly querists I would only say how much pleasure it has given me to answer their many questions.

Of my own labours past and intended I may speak without self-vanity. My desire is to advance the popularity of the science, and to extend its beneficial influences. My own articles on "Common Fossils," with the "Gems of Private Collections," will give me the opportunity of figuring all the British species of fossils; and that the unavoidable inconvenience of having to follow a consecutive order may be less felt, it is my intention to give from time to time special papers on particular well-known fossiliferous localities, such as Folkestone, Bridlington, Scarborough, the Isle of Wight, &c., by which means those of our readers living on other rock-formations than those treated of in the regular order of our course, may derive some advantage from the figures of fossils and descriptions of the strata with which those projected papers will be illustrated.

To Sir Roderick Murchison, Professor Huxley, Professor Ramsay, Messrs. Salter and Etheridge, Mr. Long the Librarian, and to other gentlemen of the Geological Survey; as also to Professor Owen, Mr. Waterhouse, Mr. Woodward, Mr. Davis, and other gentlemen at the British Museum, I have to express my thanks for the facilities afforded me on all occasions when I have had occasion to visit the departments under their respective controls.

Lastly, to my sincere and valued friend the Assistant-Secretary of the Geological Society, I have again to express my warmest thanks for many kindnesses, personal and editorial.

S. J. M.

London, December, 1859.

To the Rev. W. S. Symonds, F.G.S., the Rev. T. Wiltshire, F.G.S., the Rev. Dr. Anderson, Dr. Phipson, Count Marschall, Dr. Bevan, Dr. G. D. Gibb, F.G.S., Professor Harkness, M. Jules Marcou, Messrs. H. C. Salmon, F.G.S., H. C. Sorby, F.R.S., F.G.S., Edw. Wood, F.G.S., W. Pengelly, F.G.S., Geo. Tate, G. E. Roberts, H. Mitchell, and the too long list of contributors for insertion here my grateful thanks are due. And to my numerous friendly querists I would only say how much pleasure it has given me to answer their many questions.

Of my own labours past and intended I may speak without self-vanity. My desire is to advance the popularity of the science, and to extend its beneficial influences. My own articles on "Common Fossils," with the "Gems of Private Collections," will give me the opportunity of figuring all the British species of fossils; and that the unavoidable inconvenience of having to follow a consecutive order may be less felt, it is my intention to give from time to time special papers on particular well-known fossiliferous localities, such as Folkestone, Bridlington, Scarborough, the Isle of Wight, &c., by which means those of our readers living on other rock-formations than those treated of in the regular order of our course, may derive some advantage from the figures of fossils and descriptions of the strata with which those projected papers will be illustrated.

To Sir Roderick Murchison, Professor Huxley, Professor Ramsay, Messrs. Salter and Etheridge, Mr. Long the Librarian, and to other gentlemen of the Geological Survey; as also to Professor Owen, Mr. Waterhouse, Mr. Woodward, Mr. Davis, and other gentlemen at the British Museum, I have to express my thanks for the facilities afforded me on all occasions when I have had occasion to visit the departments under their respective controls.

Lastly, to my sincere and valued friend the Assistant-Secretary of the Geological Society, I have again to express my warmest thanks for many kindnesses, personal and editorial.

S. J. M.

London, December, 1859.

PREFACE.

To the Rev. W. S. Symonds, F.G.S., the Rev. T. Wiltshire, F.G.S., the Rev. Dr. Anderson, Dr. Phipson, Count Marschall, Dr. Bevan, Dr. G. D. Gibb, F.G.S., Professor Harkness, M. Jules Marcou, Messrs. H. C. Salmon, F.G.S., H. C. Sorby, F.R.S., F.G.S., Edw. Wood, F.G.S., W. Pengelly, F.G.S., Geo. Tate, G. E. Roberts, H. Mitchell, and the too long list of contributors for insertion here, my grateful thanks are due. And to my numerous friendly querists I would only say how much pleasure it has given me to answer their many questions.

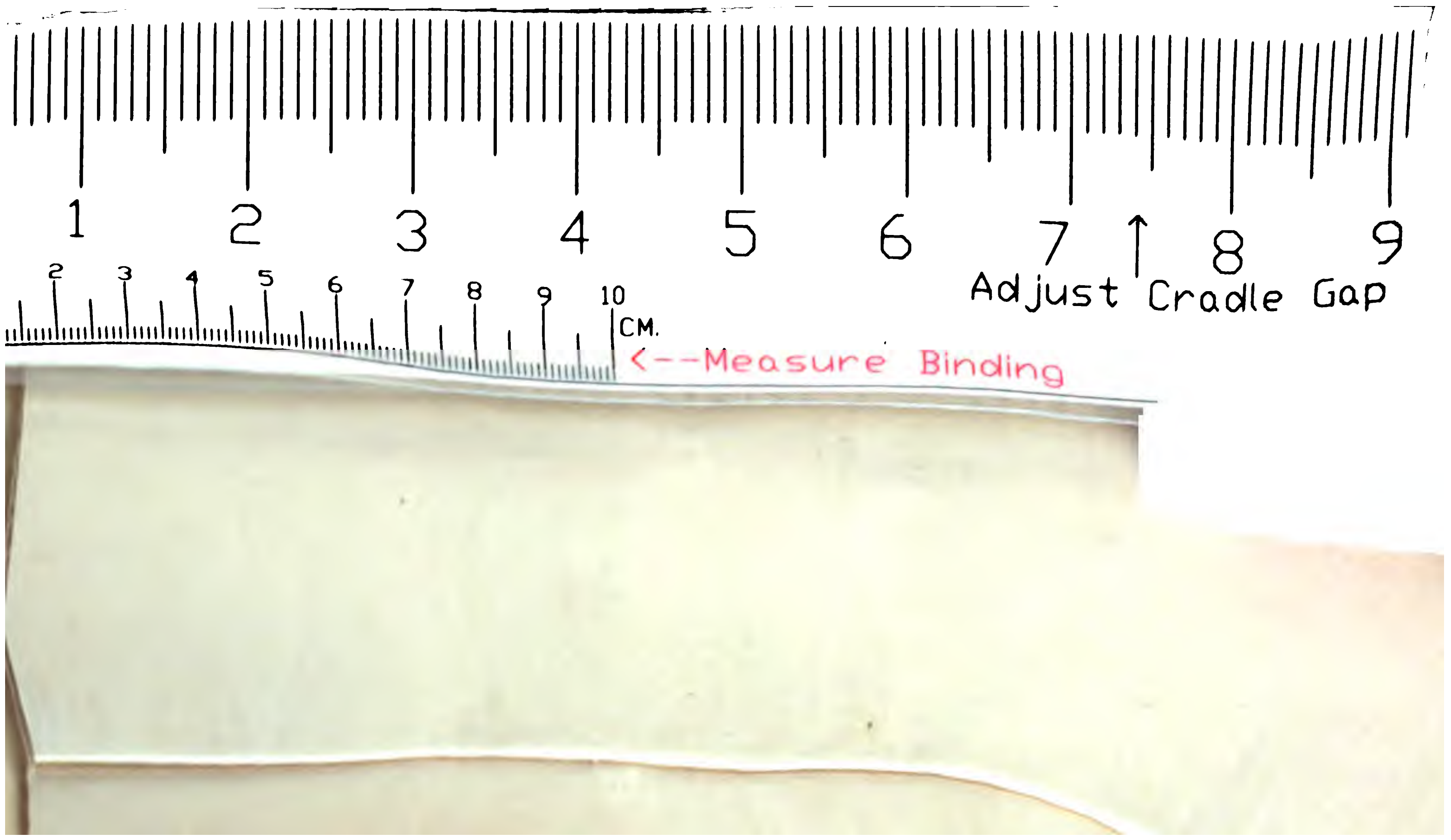
Of my own labours past and intended I may speak without self-vanity. My desire is to advance the popularity of the science, and to extend its beneficial influences. My own articles on "Common Fossils," with the "Gems of Private Collections," will give me the opportunity of figuring all the British species of fossils; and that the unavoidable inconvenience of having to follow a consecutive order may be less felt, it is my intention to give from time to time special papers on particular well-known fossiliferous localities, such as Folkestone, Bridlington, Scarborough, the Isle of Wight, &c., by which means those of our readers living on other rock-formations than those treated of in the regular order of our course, may derive some advantage from the figures of fossils and descriptions of the strata with which those projected papers will be illustrated.

To Sir Roderick Murchison, Professor Huxley, Professor Ramsay, Messrs. Salter and Etheridge, Mr. Long the Librarian, and to other gentlemen of the Geological Survey; as also to Professor Owen, Mr. Waterhouse, Mr. Woodward, Mr. Davis, and other gentlemen at the British Museum, I have to express my thanks for the facilities afforded me on all occasions when I have had occasion to visit the departments under their respective controls.

Lastly, to my sincere and valued friend the Assistant-Secretary of the Geological Society, I have again to express my warmest thanks for many kindnesses, personal and editorial.

S. J. M.

London, December, 1859.


1
2
3
4
5
6
7
8
9
Adjust Cradle Gap
2
3
4
5
6
7
8
9
10
CM.
<--Measure Binding

THE GEOLOGIST.

JANUARY, 1859.

ON THE NEOCOMIAN AND THE WEALDEN ROCKS IN THE JURA AND IN ENGLAND.

By M. Jules Marcou, Professor of Geology in the Federal Polytechnic
School, Zurich.

N June, 1827, Dr. W. H. Fitton read before the Geological Society of London the following statement:—"It is obvious that, during a period of time sufficient for the accumulation of the Wealden, the eposition of matter in the adjacent seas could not have been nconsiderable; so that we might expect to find, interposed between he strata which then formed the bottom of the sea and the Lower reensand, a series of beds coeval with the Wealden in point of date, ut differing from it in possessing the characters of a marine deposit, nd including marine shells and other productions of salt water; with hich, near the shore, the productions of the land, or even the fresh-ater shells of the rivers, might be occasionally intermixed. . . . . t. That the Wealden and its marine equivalent could not both be und in the same place; and consequently (since we have the former England) that the *marine* beds of that date are not to be expected nerally in this country; 2dly. That the marine fossils of the beds temporaneous with the Wealden would probably be distinct, both om those of the Portland group beneath, and of the Greensands ove them; a consideration which gives peculiar interest to the ssils of this intermediate group."* Since that day, the Neocomian formation has been found and named; its rocks and fossils have been described; and the Purbeck beds have returned to their former associates—the Jurassic rocks.

---

* See *Observations on some of the Strata between the Chalk and Oxford Oolite the South of England.* Transact. Geol. Soc. 2 Ser. vol. iv. p. 329.

During this period of time several geologists have tried to find the marine equivalents of the Purbeck and Wealden rocks, without, however, arriving at results satisfactory to all observers. The question is still very far from a solution; but I have lately learned several new facts on the subject which perhaps may be of some assistance in facilitating a recognition of the marine deposits coeval with the Wealden.

In order that my references and data may be clearly understood, I will first give a short description, or *résumé*, of the strata in the Jura Mountains comprised between the Portland stone and the Lower Greensand. This *résumé* is also graphically presented in the *Abstract section of the series of strata comprised between the Banné Limestone and the Rhodanian group, in the Jura Mountains* (Pl. I., Fig. 1)—under the form of a tabular and proportional view.

The Jurassic divisions known under the names of Banné Limestone (*Calcaires du Banné*) and Salins Marls (*Marnes de Salins*)* contain a fauna identical with that of the Portland beds, with the addition of some new species peculiar to the Jura, and a few fossil shells common to the Kimmeridge clay. The Salins Marls are succeeded by a series of compact limestone strata, very thick (100 feet at least), of a whitish-grey, and sometimes clear yellow colour, containing beds of lithographic stone a little above the middle of the division, and always capped by a sort of magnesian limestone (Dolomite). This series, called Salins Limestone (*Calcaires de Salins*), contains numerous fossil remains, all of marine animals, especially Corals, Echinodermata, Nerinea, and Natica; two hundred different species at least. The *Leitmuscheln* (guide-shells) are:—*Hemicidaris Purbeckensis*, Forb.; *Pygurus Jurensis*, Agass.; *Pinna Barrensis*, Buv.; *Trigonia gibbosa*, Sow.; *Natica Marcousana*, D'Orb.; *N. Athleta*, D'Orb.; *Rostellaria Barrensis*, Buv.; *Nerinea Salinensis*, D'Orb.; *N. Elea*, D'Orb.; *N. subpyramidalis*, D'Orb.; *N. grandis*, Volt.; *N. trinodosa*, D'Orb.; *N. cylindrica*,

---

* See, for explanation of these terms, *Lettres sur les Roches du Jura et leur distribution géographique dans les deux Hémisphères*, par Jules Marcou; Paris, 1857.

D'Orb.; *Stylina intricata*, From.; and *Thamnastræa dumosa*, From. Typical localities; vicinity of Salins, Gray, Besançon, Montbéliard, and Borrentruy.

The Salins Limestone terminates the Jurassic strata, and a well-marked discordance of stratification exists between it and the Neocomian rocks; a discordance varying from 5° to 15°, and which may be seen on all the flanks of the different longitudinal valleys of the Jura.

The Neocomian rocks are divided into three groups: the Lower Neocomian, or St. Croix group; the Middle Neocomian, or Château group; and the Upper Neocomian, or Noirvaux group.

The Lower Neocomian has its type in the vicinity of St. Croix, a village in the Canton de Vaud, celebrated for the numerous and successful researches of Dr. Campiche, who has collected there the most complete set of Neocomian fossils in existence. Professor Pictet describes them in his *Matériaux pour la Paléontologie Suisse*, seconde série; *Description des fossiles du Terrain crétacé de Ste. Croix*, now in course of publication. The St. Croix group may be divided into three principal parts, (*a*) the Villars Marls, (*b*) the Auberson Rocks, and (*c*) the Métabief Limonite.

(*a*). The Villars Marls (*Marnes de Villars*), forty feet thick, consist of very hard, grey marls, alternating near the top with marly and very compact limestone. In some places, such as Renaud du Mont, La Rivière, and Foucine, the marls become green and even variegated, and then contain layers of white gypsum and dolomitic limestone. Professor Lory of Grenoble has found freshwater shells in this division, such as *Planorbis Loryi*, Coq.; *Physa Wealdina*, Coq.; *Paludina*, *Cyclas*, *Anodonta*, &c.; and M. Renevier has lately discovered the *Corbula alata*, Sow., which indicates a mixture of brackish-water animals. The typical localities for fossils are, Villars-le-lac near Morteau, Charix near Nantua, Jongue, Les Rousses, and Cinquétral near St. Claude.

(*b*). The Auberson Rocks (*Roches d'Auberson*), eighty feet thick, are composed of a series of compact, whitish, oolitic limestones, with beds of blue and yellow marls, varying in thickness from half-a-foot to ten or twelve feet, intercalated near the base. The marls contain in great quantity a small sea-urchin called *Toxaster Campichei*, Pic., and a small *Terebratula* related to the *Ter. biplicata*, var. *acuta*, von Buch. In the limestone beds are found, *Strombus Sautieri*, Coq.; *Sigaretus Pidanceti*, Coq., and the *Natica Sautieri*, Coq. The typical localities are, the Auberson Valley, near St. Croix, St. Cergues, and Les Rousses.

(*c*). The Métabief Limonite (*Limonite de Métabief*), forty feet thick, is generally a reddish limestone, containing oolitic iron-ore; the strata are thin, and easily decomposed by atmospheric action. In some places, as in the valley of Nozeroy, blue marls exist at the base of this division. The fossils are very numerous, and beautifully preserved; those characteristic are—*Chelonia Valenginiensis*, Pic.; Crocodile; *Plesiosaurus Neocomiensis*, Camp.; *Pycnodus cylindricus*, Pic.; *Asteracanthus granulosus*, Eger.; *Ammonites Gevrilianus*, D'Orb.; *A. Marcousanus*, D'Orb.; *Nerinea Marcousana*, D'Orb.; *Pholadomya Scheuzeri*, Agass.; *Pygurus rostratus*, Agass.; *Hemicidaris patella*, Agass.; *Acrocidaris depressa*, Gras.; *Catopygus Renaudi*, Agass.; &c. Typical localities: Métabief, Boucheraus, and St. Croix.

The Middle Neocomian, or the Château group, as it is called in reference to the castle of the town of Neuchatel, the foundation of which rests entirely on this group, is composed of three divisions; (*a*) the Hauterive clay, (*b*) the Ecluse rocks, and (*c*) the yellow, or Neuchatel stone.

(*a*). The Hauterive clay (*Marnes d'Hauterive*), thirty feet thick, consists of blue and sometimes plastic clay, with more or less of a yellow tint and very numerous fossils; the most common are, *Toxaster complanatus*, Agass.; *Diadema rotulare*, Agass.; *Terebratula prælonga*, Sow.; *Ter. Marcousana*, D'Orb.; *Rhynchonella depressa*, D'Orb.; *Ostrea Couloni*, Defr.; *Corbis cordiformis*, D'Orb.; *Trigonia caudata*, Agass.; *Venus Dupiniana*, D'Orb.; *Panopea Neocomiensis*, Agass.; *Cardium Voltzii*, Leym.; *Pleurotomaria Neocomiensis*, Agass., &c. It is easy to distinguish three zones in these clays, characterised by different associations of fossils; the lower zone, or Censeau beds, the middle, and the upper zone. Typical localities: Hauterive, near Neuchatel, St. Croix, Censeau, Nozeroy, &c.

(*b*). The Ecluse rocks (*Roches de l'Ecluse*), forty feet thick, are composed of yellowish, often green, spotted limestone, alternating near the base with yellow marls. Characteristic fossils: *Rhynchonella depressa*, Sow.; *Ostrea Bousingaultii*, D'Orb.; *Lima Royeriana*, D'Orb.; *Pecten Cottaldinus*, D'Orb., &c. Typical localities: the Ecluse behind Neuchatel Castle, and Censeau.

(*c*). The Neuchatel stone, or yellow stone (*Pierre jaune ou Pierre de Neuchatel*), sixty feet thick, is the beautiful material which gives to the buildings of the town of Neuchatel that clear yellow colour so much admired by travellers. Fossils are rare in this division, and never in a good state of preservation. Typical localities: vicinity of Neuchatel and Pontarlier.

The Upper Neocomian, or Noirvaux, group is well developed in the Noirvaux valley near St. Croix; it is this group, or rather the fauna contained in its strata, that D'Orbigny has called *Urgonian.* Two divisions are generally found in it; (*a*) the Mauremont rocks, and (*b*) the Noirvaux-Dessus Limestone.

(*a*). The Mauremont rocks (*Roches du Mauremont*), forty feet thick, consist of yellow limestone, very difficult to distinguish from the division below; they become marly, and finally terminate with a bed of yellow marls containing numerous fossils. The characteristic fossils are: *Janira atava*, D'Orb.; *Toxaster Couloni*, Camp.; *Pygurus productus*, Agass.; *Cidaris clunifera*, Agass.; *Caprotina Dubuisii*, Mèr.; *Rhynchonella lata*, D'Orb., &c. Typical localities: Mauremont in the Canton de Vaud; St. Croix, Travers, Bôle, &c.

(*b*). The Noirvaux-Dessus Limestone (*Calcaires de Noirvaux-Dessus*), one hundred and ten feet thick, has been often called the *Caprotine Limestone;* it is a series of beautiful white and sometimes yellow limestones, affording a marble much employed at Thoiry, near Geneva. Characteristic fossils: *Caprotina ammonia*, D'Orb., and *Radiolites Neocomiensis*, D'Orb. Typical localities: Noirvaux-Dessus, near St. Croix, Thoiry, Les Rousses, &c.*

The strata of the Greensand formation lie directly above the Neocomian and in concordance of stratification. Eugène Renevier, who has made a special and very successful study of the Greensands in England and at the Perte du Rhône, considers the lower Perna-bed, containing the *Natica rotundata*, Sow., &c., of the Lower Greensand of the Isle of Wight, to be the equivalent of the yellow clay (*Marnes jaunes*) containing *Natica rotundata*, Sow., &c., of his Rhodanian group of the Greensands of the Perte du Rhône.

---

* For a more detailed account of the Neocomian Strata, see *Sur le Néocomien dans le Jura et son rôle dans la série stratigraphique*, by Jules Marcou. Genève, 1859.

I have given a rough sketch under the form of a tabular and proportional view (Pl. I. Fig. 2)—*Abstract Section of the series of strata comprised between the Portland stone and the Lower Greensand, in the South-Eastern part of England*—for the sake of comparison.

The Banné Limestone and Salins Marls being the equivalents of the Portland beds, and the Rhodanian presenting exactly the fauna of the "*Perna-beds*" and "*crackers*" of the Lower Greensand, it appears rational to conclude that the Purbeck beds, the Hastings sands, and Weald clay, are fluvio-marine and terrestrial deposits coeval with the marine deposits known in the Jura under the name of Salins Limestone and Neocomian.

A few marine fossils, or, at least, belonging to brackish-water animals, have lately been found common to the two series in the Jura and in England, and they may serve as landmarks for future investigations.

In the first beds of the Salins Limestone, immediately above the Salins Marls, the *Trigonia gibbosa*, Sow., is quite abundant, and in a good state of preservation. Fitton says, that the last bed in the Portland quarries, called by the quarrymen "roach," contains a great quantity of *Trigonia gibbosa*. So we may suppose that the "roach" of Portland is equivalent to the first beds of the Salins Limestone, or a little older. I have indicated both suppositions by dotted lines uniting the two abstract sections. In both countries, the stratigraphical position of the *Hemicidaris Purbeckensis*, Forb., forbids the supposition that the "roach" may be younger than the Salins "Trigonia gibbosa beds." Until now, palæontologists and geologists have regarded the Echinodermata as more characteristic than the Acephala and Gasteropoda, and of equal importance with the Cephalopoda and Brachiopoda. As an example of their importance, it is sufficient to say that Forbes replaced the Purbeck beds in the Jurassic rocks, because he discovered a Hemicidaris in the "Cinder-bed" near Swanage. That Hemicidaris was new, and he called it *Hemicidaris Purbeckensis*.

A few years later, the same species was signalized in France by Cotteau, who had it from the Salins Limestone of Burgundy (see *Etudes sur les Echinides fossiles du département de l'Yonne*, vol. i. p. 300). But Cotteau says that his three specimens belong to a variety of the species described by Forbes, who found only a single complete specimen; and the *Hemicidaris Purbeckensis* is regarded as a rare fossil in Purbeck, and also in Burgundy.

During my explorations of the Jura in 1844-47, I met with fragments of a Hemicidaris in the Salins Limestone several times; and when Forbes published his *Hemicidaris Purbeckensis*, I perceived at once the possibility of an identity with the Jura sea-urchin; and on making a rapid excursion to Portland in 1852, I saw immediately that the strata called in the Jura *Portlandian* were not equivalent to the Portland-stone of England, but a little younger. Having learned that a well-preserved Hemicidaris had lately been found by M. Perron, of Gray, in the Salins Limestone near that town, I wrote to call his attention to the subject; and the result of researches made by him and M. Etallon is, that the Hemicidaris of Gray is identical in all respects with the *Hemicidaris Purbeckensis*. MM. Perron and Etallon say that their specimens do not indicate any variations from the true *Hemicidaris Purbeckensis* of Professor Edward Forbes; and this beautiful fossil is quite common even with the spines adherent to the shell.

The exact position of the *Hemicidaris Purbeckensis* at Gray is about thirty feet from the base of the Salins Limestone. There are also some indications of the existence in the Salins Limestone of the *Exogyra bulla*, Sow., and *Ostrea distorta*, Sow., but nothing positive as yet.

Relying only on the *Hemicidaris Purbeckensis*, it is, however, quite probable that the Salins Limestones are the marine deposits coeval with the Purbeck beds; especially if we consider that in England a change of some note takes place in the distribution of deposits; for the Hastings Sands and Weald Clay range through a very different part of the country from the Purbeck strata. The discovery of the *Hemicidaris Purbeckensis* in the last division of the Jurassic rocks in the Jura mountains shows the soundness of Forbes' view when he replaced the Purbeck beds in the English Oolites.

The Villars Marls contain a fluvio-marine fauna, which will aid us in the endeavour to find the equivalents in the two countries, and the more as we now know that Professor Lory, of Grenoble, has found in Dauphiné the marine deposit coeval with them. Until now, only one species truly identical with an English fossil has been discovered in the Villars Marls: it is the *Corbula alata*, Sow., known in the Ashburnham beds of Pounceford, near Burwash, Sussex.

Professor Pictet has lately recognised among the fossils picked up at St. Croix, in the Métabief Limonite, a well-preserved spine of the *Asteracanthus granulosus*, Eger., a fish found by Mantell in the middle division of the Tilgate beds. It is interesting to add that Campiche, Pictet, and some other Jurassian geologists, have found in the same Métabief Limonite numerous vertebræ, teeth, and scales of Plesiosaurus, Crocodiles, and fishes, indicating that a rich fauna of vertebrated animals existed there during the deposits of the Métabief beds (see *Description des fossiles du Terrain crétacé de Sainte Croix*, par Pictet et Campiche. Genève, 1858). If we remark that the middle division of the Tilgate beds is precisely where Dr. Mantell found such numerous remains of Plesiosauri, Crocodiles, Iguanodons, fishes, &c. ; it is not improbable that we may synchronize the Lower Neocomian with the Lower part of the Hastings Sands, from the Middle division of the Tilgate beds downwards, with some degree of truth. I have indicated this supposed synchronism by dotted lines. (See Pl. I. *Abstract sections*, &c.)

We have as yet no palæontological evidence that will permit us to identify the Middle and Upper Neocomian with the upper part of the Hastings Sands and the Weald Clay; but, if the preceding synchronisms be exact, we may accept this also on stratigraphical grounds.

At all events, it appears from the preceding remarks,—1st, that the Neocomian is not the equivalent of the Lower Greensand; 2d, that the Purbeck beds are coeval with the marine deposits called, in the Jura, Salins Limestone; 3d, that there is great reason to suppose that the Neocomian of the Jura is the marine equivalent of the Wealden of Kent, Surrey, and Sussex; and that the great gap existing in Great Britain in the marine deposits between the strata of Portland and those of the Lower Greensand will be filled up by the Neocomian and the Salins Limestone of the Jura Mountains.

NOTE ON THE SPEETON CLAY OF YORKSHIRE.

By JOHN LECKENBY, Esq., of Scarborough.

THE lowest beds of Speeton Clay in overlying contact with any inferior stratum have never been found in Filey Bay, but a little to the south of a point where it is first exposed Lias "scars" exist with *Ammonites communis* and *A. Walcotti* in situ, showing great upheaval or disturbance, or else great unconformability here.

1. The lowest known beds of Speeton Clay, so called, consist of blue clay, with seams of septarian nodules. In one of these seams, in beds of a black claystone, specimens of *Ammonites biplex* three to four inches in diameter are not unfrequent. This is the only fossil found in this bed.

2. Above this is a band of strong, slaty, brown clay, very ligneous and peaty, containing remains of fishes only. Here was found the unique *Palæoniscus Egertoni*, now in the possession of the Earl of Enniskillen. Thickness . . . . 12 feet.

3. Next we have a black shaly clay, containing large nodules like the cement-stones, but not used as such. These nodules contain a beautiful Ammonite, named by Mr. Bean *A. evalidus*, but no other Mollusca. . . . . 20 feet.

4. Another band of strong clay, containing compressed Ammonites and other shells, all too imperfect for discrimination. This band is traversed at intervals by seams of septarian nodules. . . . 50 feet.

5. A thin seam of impure clay, with fragments of Ammonites and Belemnites. . . . . 1 foot.

6. A stratum of dark-brown shaly clay, containing imperfect, compressed, bivalve shells, and a seam of coprolitic nodules. . . 5 feet.

7. Compact light-grey argillaceous stone, destitute of fossils; forming a remarkable line of demarcation between the beds below and those succeeding. . . . . 3 feet.

8. Tough and almost pure clay, containing many of the characteristic fossils of the Speeton Clay as under. . . . . 8 feet.

Serpula vertebralis.
Astarte sinuata (Bean).
——— a larger species.
Nucula ovata.
——— *subrecurvum.*

Cucullea.
Gryphæa sinuata.
Pecten (undescribed).
Ammonites quadrifidus.
——— *cavaticus.*

9. An impure micaceous sandy clay, containing many nodules, and numerous fragments of Ammonites and Belemnites; apparently the detritus of a previous deposit. It also contains many ribs and vertebræ of Saurian animals . . . . 5 feet.

In this bed we find—

Pholadomya decussata.
Mya (?) *depressa.*
Cytherea plana.
Inoceramus concentricus.

Terebratula subundata.
Avicula multicostata.
Rostellaria Parkinsoni.
Pleurotomaria (undescribed).

10. A clay similar to 7, but of a higher colour, containing—

Serpula vertebralis.
Belemnites jaculum.
B. subrecurvum.

Turbo pulcherrimus.
Cerithium, n. s.
Nucula ovata.

At its base is a thin pyritic layer, rich in beautiful Ammonites.

Ammonites currindus. *A. regalis* (Bean, MS.). *A. furcellatus.*

Thickness 4 feet.

11. A band similar to 9, with similar fossils. Thickness . 2 feet.

12. A strong band of blue clay, with a few imperfect fragments of Ammonites. . . . . 3 feet.

13. A bed of whitish claystone, containing a species of Astacus (not in nodules) and two very well marked distinct species of Ammonites,—*A. munitus* (Bean, MS.), and a species in which the costæ of the outer whorl are so deeply divided as to cut half through the whorl. 1 foot.

14. Another band containing compressed flattened casts of bivalves, all imperfect, and *Ammonites marginatus* . . . . 4 feet.

15. The great band of Hamites, comprising *H. maximus* and kindred forms, sometimes free, when they are generally crushed except the last chamber, representing about half a whorl; often in nodules, and then better preserved. . . . . 1½ feet.

16. Another bed of Hamite-like Cephalopods; not the same as the last; comprising *Crioceras Beanii* and kindred forms, often of immense size. . . . . 3 feet.

17. Blue clay with Ammonites and Belemnites as under :—

Ammonites rotula.
——— *venustus.*
——— *concinnus.*
——— (variety with coarser radii).
Belemnites jaculum.
——— (a short thick species).
Thickness 12 feet.

18. A band of clay without fossils except traces of decomposed Hamites. . . . . 8 feet.

19. The remarkable "Astacus ornatus bed," with innumerable nodules, each containing an Astacus (*Astacus* (?) *ornatus*, Ph.). 3 feet.

20. Strong clay without fossils. . . . . 15 feet.

21. Another thick deposit containing no fossils except the outer whorl of a large undescribed Ammonite. . . . . 50 feet.

22. Another thick bed of stratified clay, forming the Cliff; the lowest portion full of crushed imperfect bivalves (*Mya depressa*); through its centre runs a band of cement-stone, containing a large smooth Ammonite, and fragments of *Hamites maximus;* and immediately above the cement-stone-band is a seam of soft stone with *Vermicularia Sowerbii.* . . . . 50 feet.

The cement-stone yields—

Hamites Banksii (Bean).
Ammonites fissicostatus.
Auricula.
Plagiostoma.

The occurrence of *Vermicularia Sowerbii* and *Ammonites fissicostatus*, which so nearly resembles *A. Deshayesi* of the Greensand of the Isle of Wight as to be almost inseparable, would seem to refer the upper portion of these beds to the Neocomian era; while so characteristic an Ammonite as *A. biplex* in the lowest beds would with equal certainty refer the lower ones to the era of the Kimmeridge Clay. Between them we have probably the representatives of the Gault in the Hamite-yielding beds, while we are puzzled to account for the presence of such true Oxfordian forms as the coronated Ammonites, *A. quadrifidus* and *A. caveatus*, although perhaps these are not more erratic than *A. Parkinsoni*, which, while it characterizes the Inferior Oolite of the south, occurs in the Grey Limestone at Scarborough, not seventy feet below the Cornbrash.

ON THE GEOLOGY OF THE SCILLY ISLES.

By the Rev. FRANCIS F. STATHAM, B.A., F.G.S., Incumbent of St. Peter's, Walworth.

(*Read before Section C.* (Geology) *of the British Association for the Advancement of Science, on Thursday, September* 23, 1858.)

THE majority of persons, merely acquainted with the name and position of the Scilly Isles, generally associate in their mind with the mention of this group a cluster of rugged rocks, affording shelter and sustenance to a few poor fishermen and pilots, and famous for nothing else than the frequent shipwrecks and naval disasters of which in times past they have been the scene. From their isolated position, and their comparative difficulty of access, they have been much less frequently visited, and less accurately described, than many other of the beautiful islets which surround our favoured shores; hence much misapprehension prevails both as to their extent and their capabilities, while very little indeed, of a scientific character, has been put on record with reference to their varied attractions, zoological, botanical, or geological.* A visit of three weeks, during the past summer, having enabled me to make a few cursory observations, I have imagined that, in the absence of more definite knowledge, they may prove interesting, or, at any rate, that they may serve to attract attention to the very curious phenomena which these islands present to the student of geologic truth. The entire group consists, it is said, of 145 rocks, or rocky islets, varying in size from the mere solitary crag jutting out at low water from the surface of the ocean, to the Isle of St. Mary, the largest, the most populous, and the most fertile of the whole, which measures about three miles by two and a half miles, and contains an estimated area of about 1,640 acres. The Scilly Islands lie in latitude 49° 57′ N., and in longitude 6° 43′ W. bearing west by south from the Land's End, and due west from the Lizard; from the former point they are distant little more than twenty-seven miles in a direct line, though the distance from Penzance pier, the usual starting-place of the vessels from the mainland to St. Mary's Pool, is about forty miles. So far from being mere rugged rocks, these islands afford a pleasant home to between two and three thousand inhabitants, the total population having been computed in 1851 at 2,601 souls, the majority of whom dwell upon St. Mary's, although five of the other islands—viz., Tresco, St. Martin's, St. Agnes, Bryer, and Sampson's—have a scattered population upon them nearly in proportion to their relative size. As the character of the rocks, being almost exclusively granitic, is very similar to that of the extreme promontory of Cornwall, it has been suggested by some writers that they may have been originally united to the mainland, and traditions are not wanting, of a very ancient date, which might serve to confirm this opinion, were there not many countervailing reasons to be alleged in opposition. From the circumstances that the Gulf, or Woolf Rock, which lies midway between Scilly and Land's End, is of *greenstone*, and not of granite, and that, in dredging the sea-bottom between these two points, shells and sea-weeds have been occasionally brought up clinging to greenstone, or clayslate, it is conceived that a tract of metamorphic rocks exists beneath the ocean between the mainland and the Scilly Isles, and that the latter are thus outliers only of the great granitic range of Devonshire and Cornwall. Many circumstances tend to prove that the conformation of the islands is very different now from what it has been at a former period, within even historic times. Local tradition asserts that anciently there was a narrow causeway by which persons could pass across Crow Sound from St. Mary's to St. Martin's, and the ledge of rock which is visible at low water a little below the surface in this part is still called the "Pavement." Then, again, the Gugh, which, in the time of Borlase (about 100 years ago), was described as "a part of Agnes, and never divided from it but by high and boisterous tides," is now at each period of spring-tides an island, and there is then sufficient depth of water in mid-channel for a boat to shoot across the bar. These considerations would seem to show that there has been a decided sinking of the land in the vicinity of these islands even during the last century. Another fact, which came to my knowledge while sojourning in the isles, confirms me in this opinion. The masons who had been engaged in laying the foundations of a large warehouse, belonging to Mr. Edwards, a short distance from the strand in the Pool of St. Mary's, assured me that when they had dug down several feet below the surface, they came across the remains of former wooden buildings which, at one time, must have been above the level of the sea, although they were thus found considerably below it.

---

* With the exception of an admirable paper read before the Geological Society of Cornwall, in Sept., 1850, by Joseph Carne, Esq., F.R.S., F.G.S., &c., and a few brief lines in one of the earlier volumes of the Transactions of that Society, I am not aware of any notices of the geology of these islands which have been offered to the public.

Possibly, at no very remote period, geologically speaking, the whole of this group to the north, including Bryer, Tresco, St. Martin's, and the adjoining islets, have formed one continuous island, the soundings between the contiguous portions being still very shallow, so much so that several of them can be reached from the others by walking over the bars at low water. The question of their continuity at any former time with the mainland is one of greater difficulty; for although the tradition previously referred to speaks of a large tract of country covered with parish churches, and called the "Leonais," as formerly uniting Scilly with Cornwall—and there are not wanting stories also of the remains of windows and doorways having been seen midway beneath the ocean in seasons of clear weather—yet no facts of a geologic character, in any way bearing out this view, have as yet been ascertained. I made the most careful search, during my stay in the islands, to discover, if it were possible, any traces of greenstone or clayslate in those parts of the islands looking towards the Cornwall shores, but I could discover nothing of the kind. On the summit of the promontory called the Hugh, forming a part of St. Mary's, I did indeed find clayslate; and on the very highest point of Newford Down, in a pit not far from the Telegraph Station, I met with similar traces; but both of these points would be out of the line of communication with the nearest points of the Cornish coast, and they are only interesting inasmuch as they prove that some land, higher than any now existing in St. Mary's, has formerly consisted of metamorphic rocks, the broken fragments of which, after having been subjected to the action of water, have been deposited in an irregularly stratified manner amidst the shattered *débris* of the surrounding granitic rocks. The position in which I found these solitary traces of slate-rock was in a pit to the right of the path leading from the Star Fort, on the Hugh, to the two dismantled windmills on the summit of the Downs. The pit consists almost exclusively of crumbling granitic rubble, so frequently met with almost immediately beneath the surface-soil in these islands; but, in one corner of the pit, that to the south, the character of the rubble is entirely changed, and it consists of irregular angular fragments of hard clayslate, many of them of considerable size, lying in a kind of rough order, as though they had been broken by the action of the elements from some higher spot, and had rolled down and become tightly wedged in the position in which they are now found. Lying at no great distance (probably two feet) below the existing level, and isolated altogether from all the traces of any other rocks of a similar character, I was almost inclined to think, at first, they might have been the rough fragments left after some building-operations, which, in the lapse of ages, had allowed the surface-ground to have gradually formed above them; but a closer inspection of the pit assured me that this could never have been the case; indeed, the fragments were so diverse in shape, and their position in the midst of the granitic rubble so unmistakeable, that I could form no other opinion than that they belonged to some different class of rocks, now destroyed, and leaving no traces of their previous existence, save in these buried fragments.

The general appearance of this group of islands, when approached from the east, is that of smooth, swelling lowlands, scattered in picturesque confusion on the bosom of the deep; Hangjague alone presenting the appearance of a rugged precipitous crag, almost of the shape of a sugar-loaf, and gleaming white in the sun. But, if visited from the north, by way of Round Island and Menavawr, or from the south-west, passing the Bishop Rock, the Crebawethans, and Annette, the aspect of the islands is entirely changed, and they show forth in all their dangerous and romantic beauty, fringing the sea with pinnacled crags and battlemented headlands, against which many a gallant vessel has dashed and gone down with its terrified crew. The cause of this difference of aspect is obvious. The wide Atlantic, rolling in its tremendous waves during stormy seasons of the equinoxes, sweeps against these exposed sides with almost incalculable force. To form some idea of its power when thus lashed into fury by the winds, it may suffice to mention one fact, which is not in itself devoid of geological interest, inasmuch as it may serve to explain the occasional appearance of large blocks of stone in unexpected localities. In passing along Broad Sound from the south-east, there is an island called Great Crebawethan, which is probably in some way more exposed than others to this oceanic force. At any rate, there it is to be witnessed, standing probably eighteen or more feet out of the surface of the deep, at the highest spring-tides, with large boulders of granite, from half a ton to two tons weight, heaped upon its surface, as though the ballast of a dozen vessels had been discharged there by the hands of man, every stone of which, as I was assured by Mr. E. Douglass, the intelligent superintendent-engineer of the Bishop's Lighthouse works, has been raised to its present position, and deposited there, by the force of the waves.* The total destruction, too, of the iron lighthouse upon the Bishop's Rock, which, when near completion, was instantaneously uprooted, and dashed into the sea, on the night of February 5th, 1850, may serve to convey an impression of the violent force to which the sides of the islands facing the Atlantic lie exposed; and this will explain how it is that, when viewed in this direction, they appear rugged, precipitous, and excavated into caverns and gaps, while, approached from the eastern side, they lie smiling in the sun like fairy lands, or like the islands of the Ægean transplanted to our hyperborean shores.

As the geologic features of St. Mary's are more or less reproduced on a smaller scale in the other islands, I shall now proceed to give a detailed account of its most important characteristics. It is an irregular-shaped elliptical island, having two peninsulas attached, one to the lower, or western, extremity—viz., the Hugh, now fortified for a garrison, on the isthmus of which Hugh Town, the capital of the Scilly Islands, is built; and the other at the extreme end, south of the island, terminating in the bold promontory of Peninnis Head, which is surrounded by Path Cressa Bay, the Atlantic Ocean, and Old Town Bay. The surface of the island is very various, the higher portions being constituted by the two peninsulas above-named; and from the flat table-land of Newford Downs, an irregular ridge stretches from Inisidgen Point in the north, forking off in two branches to enclose the low marshy lands, about Carnfriars and Old Town Porth on the southern coast. The highest point probably in the whole island is the Telegraph upon Newford Down, which is 204 feet above mean water-mark; but the Downs on the top of the Hugh, and the ridge extending from Carn Thomas to Peninnis Head, cannot be much lower than this. The isthmus joining the Hugh to the mainland of St. Mary's is so low, that it has already been once or twice swept over by huge waves during severe tempests, and much injury done to the town; it is even possible that on some future occasion, should a strong breeze from the south or the south-west prevail at the time of spring-tides, it may be again devastated in a similar way, unless timely precautions be taken. From Permellin Bay on the north, to Old Town Bay on the south, the ground lies so low and exposed, that if the sinking of the land, already referred to, should continue, the sea will, at some distant period, break through these two channels, and so divide the Hugh, on the one hand, and the peninsula formed by the above-named ridge, on the other, from the mainland of St. Mary's, resolving them into three separate islands.

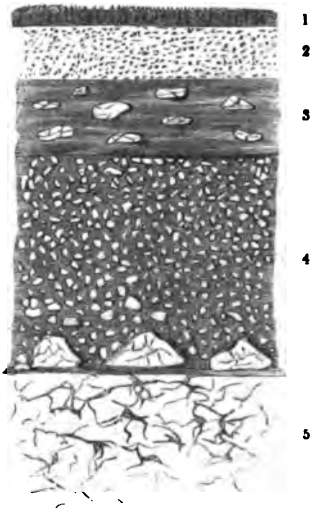
---

* Mr. Douglass also informed me that, when lodging on Rosevear island, to superintend the works connected with the Bishop Lighthouse, he had known blocks of granite twenty tons in weight to be moved some distance by the sea.

In the valuable notice of the Geology of the Scilly Isles, by Joseph Carne, Esq., of Penzance, to which reference has already been slightly made, it is stated, that at that time (1850) "no excavations worthy of the names of quarries" existed, whereby to form a judgment of the nature of the soil. Since that date, however, numerous openings (some of them of considerable depth) have been made, chiefly for the purpose of procuring ballast, or stone for building-purposes, and I was enabled, therefore, by comparison of such welcome sections, to arrive at a fair estimate of the character of the several deposits to be found. No greater mistake can be made than to imagine that these are barren or unfruitful islands. Perhaps there is no land in the whole empire, which is so fertile, or so profitable to the cultivators, as many patches which might be pointed out in Scilly and in the adjoining portions of the Cornish coast. While I was residing at St. Mary's, a notice appeared, in one of the local newspapers, of the price which a plot of ground, in the neighbourhood of St. Michael's Mount, Cornwall, had just realized. It amounted to the almost fabulous sum of twenty pounds an acre, with a covenant, on the part of the lessor, that he should still reserve to himself the right of drawing one crop per annum. The richest market-garden land in the immediate neighbourhood of London does not fetch (so far as I am aware) more than twelve pounds an acre. I was informed, too, this was no unusual price for many plots on the Cornish coast, and, though the price may not range so high as this in any of the Scilly Isles, there can be no doubt that the soil is equally fertile, and the advantages of climate perhaps even superior to those of the most favoured Cornish fields. It may seem strange that a group of granite rocks should supply the London markets with vegetables of a superior quality to those procurable from places apparently much more eligibly situate; but, nevertheless, it is a curious fact, that large fortunes have been, and still are being made, by sending up to the metropolis innumerable baskets of early potatoes—the growth of which is fostered not more by the genial character of the winter in these lonely isles than by the valuable qualities and admixtures of soil which have resulted in the course of ages from the decomposition and disintegration of the granite. I think it probable, also, that from the very circumstance of much of the soil lying immediately above the granite, it would enjoy a double advantage, viz., that of the radiation of heat upwards from the solid rock, which would obviously retain any imparted warmth derived from the sun's rays for a longer time than a less compact subsoil; secondly, the retention of a certain amount of moisture from the inability of the rain to sink very low beneath the surface. Certain it is, that with very slender means of manuring, except with burnt sea-weeds and crushed shells from the sea-shore, very abundant crops of cereals are continually reared, not only in St. Mary's, but in all the other inhabited islands, while even those which are now uninhabited afford, by their decaying stone-hedges and walls, proofs that most of them have been once fully cultivated, and are still capable of supporting a large number of inhabitants.

The various soils which are to be found superimposed upon the granite in the Island of St. Mary—and, so far as I could observe, the order and relation of them seemed precisely the same in St. Martin's, St. Agnes', and Tresco—were the following: 1st. A black surface-soil, composed of decayed vegetable matter, and in many places largely intermixed with sand, either blown up from the adjoining beach or derived from intermixture with the underlying stratum; 2d. A fine white or ash-coloured sand, in some places, as in the pit below the National Schools, containing fragments of shells; 3d. A dark reddish- or chocolate-brown clay, in many parts of considerable thickness, and having angular blocks of half-decomposed granite disseminated through it; 4th. A stratum of loose grit, or rubbly granite, locally called "ram," sometimes so comminuted as to look, at a short distance off, like a bed of cream-coloured limestone or sandstone, but more frequently coarse, and, in the portions resting upon the granite, mingled with large fragmentary masses of that rock. Finally, in the low and marshy grounds, as at Holy Vale, and in the neighbourhood of Carnfriars, traces of a band of whitish pipe-clay have been found, the position of which is most probably to be placed above the last deposit, although I was not able to meet with any section by which I could ascertain its exact order. The best locality for seeing at one view these various beds, is a pit immediately below Mount Flagon, on the bridle-path leading towards Porthloo Bay. The accompanying diagram will give a fair idea of it. Between 3 and 4 the road-path intervenes, and No. 5 constitutes the low cliff at this part of Permellin Bay. The stratum No. 2 seems to take its rise a little beyond Carn Morval Point, where it can be seen capping the cliff, which is there much higher, and running along the line of the coast. No. 2 gradually thickens as it approaches St. Mary's Bay, where it assumes the greatest depth, exhibiting, in the neighbourhood of the National School, and in a section nearly opposite the Church, sandpits of con-

Lign. 1.—Section N. Side of Permellin Bay, beneath Mount Flagon.



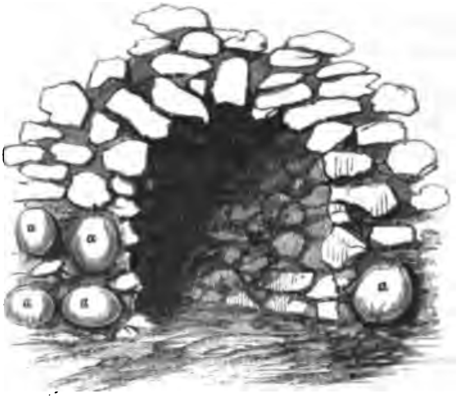
1. Black surface-soil, mixed with sand (15 inches).
2. Fine ash-coloured sand (5 feet).
3. Reddish and Chocolate-coloured clay, having large blocks of coarse granite imbedded (7 feet).
4. Grit or coarse decomposed granite rubble, with large angular masses of granite (20 feet).
5. Granite-rock.

siderable depth, from which large quantities of sand are continually carted for the purposes of ballast or manure. Other sections, similar to the above, are to be found further inland, the most interesting of which is that in a pit by the side of the road on the Green leading towards New Quay. The stratum of sand there is not, it is true, more than six inches thick, but lying, as it does, under about eight inches of soil, upon one of the highest points in the island, the section is valuable, as showing that, in all probability, at one time, the whole of the surface of the island has been capped with sand, which has been washed away from those portions where it is now deficient, leaving the underlying stratum of brown clay visible. The section in this pit I estimated as follows:—

Surface Soil, 8 inches.
Fine White Sand, 6 inches.
Brown Clay, 2 feet.
"Ram," or coarse grit, 7 feet.
Granite.

The stratum No. 3 prevails very widely over the whole island coming to the surface in all the lower lands, and forming the great bed in which agricultural and gardening operations are carried on. I traced it completely across the island to Tolman Point in one direction, and to Watermill Cove in the other. Its dark colour is in all probability due to the large proportion of oxide of iron which it has derived from the chemical decomposition of the mica of the disintegrated granite. No. 4 is a very instructive bed as developed in the various sections in which it is brought to light. It gives a thorough insight into the mode by which the apparently solid granite has in the course of ages been broken up and crumbled, and thus gradually submitted to the action of the elements, until its constituent parts have been resolved into strata serviceable to man. In many places within these islands, may be traced the several stages of decomposition, from solid masses of granitic rock, to broken fragments, thence to crumbling rubble, and to coarse granitic sand, and the final passage into aluminous and siliceous earth from the degradation and decomposition of the felspar and quartz, in many places tinged deeply with the oxides of iron from the decaying mica. That the islands have been several times submerged, during the course of these successive changes in the ages of the past, there can be little doubt; for no other hypothesis could account for the finding of beds of siliceous sand on the highest points, and those sheltered from the action of the wind. I am aware that sand is to be found at moderate heights which has undoubtedly been drifted up from below, and many portions of land which were once productive have been rendered useless from this cause.

Troutbeck, in his history of the Islands, mentions the finding of human bones interred in a spot of waste land called the "Neck of the Pool," in St. Martin's, where upwards of twenty feet of sand had accumulated in the course of time over the ground once used as a burial-place. And in St. Mary's I noticed a similar accumulation of drift-sand which, from the peculiarity of its appearance, and the shape it had assumed, was one of the most interesting features of the island. It was at the turn of the coast between Bar Point and Inisidgen Isle. The sand forming Crow Bar, and extending very widely between St. Mary's and St. Martin's, is at this point almost entirely composed of minute fragments of white quartz, so that the waters seem to repose upon a bed of porcelain, and present much the appearance of water in a swimming-bath lined with Dutch tiles. Quantities of this beautifully white sand have been blown by the strong currents of wind occasionally driving from the south-west, and have been deposited in drifts around Bar Point, and up the adjoining steep for a considerable distance. In the bright glare of a summer sun they look exactly like snow-drifts, and as you walk over them and leave impressions of your footsteps in the sand, the illusion, so far, is almost as complete as if you were suddenly transplanted into an Arctic region, and were absolutely treading upon snow. But the sand to which I have referred above as existing in the several sections, either on the coast or inland, is of a widely different character from this, or indeed from that of any other of the sands now found upon the coasts. It is finer, more strictly siliceous, and, from its compactness, evidently of more ancient deposition. I take it, therefore, that its presence upon points of the highest range is decisive as to the former submergence of the land. But there is another very curious geologic feature which will tell the same tale. Immediately behind the guard-house, inside the gateway of the garrison on the Hugh, is a kind of shallow cavern, now used as a place for storing lumber. The rough blocks of granite have fallen from the top of the entrance so as to form a rude arch, and imbedded in the rock forming the sides of the entrance are to be seen several large round boulders of granite, almost as regular as if they had been turned in a lathe, and compactly fixed in the matrix of the rock. Now this spot is considerably above the present level of the sea, probably from 150 to 180 feet, and the boulders of granite bear all the marks of having been long rolled on a rough sea-beach. Moreover, I was assured by the masons to whom I referred above, that they had been engaged in repairing the guard-house floor; and on digging beneath it, they found other boulders, of precisely the same character as those at the sides of the cave, firmly imbedded in the soil. It is manifest, then, that the spot now adjoining the guard-house must once have been on a level with the surrounding sea, or, at any rate, at no great elevation above it, for glacial action alone would be, I conceive, scarcely sufficient to account for the presence of these rounded boulders, so deeply impacted in the solid rock.



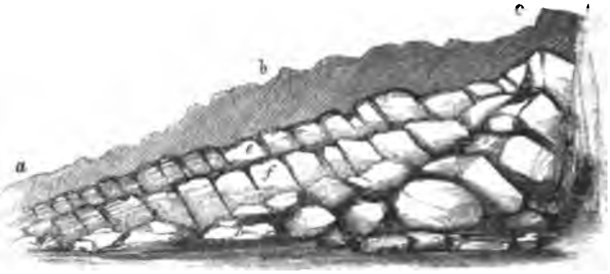
Lign. 2.—Natural Cave on the Hugh—*a*, *a*, Rounded Boulders of Granite.

It becomes interesting, therefore, to inquire whether there are any traces of volcanic or subterranean action still visible in these islands, to which this upheaving of the land, after one or, it may have been, frequent submersions, may be attributed. And a careful investigation will bring to light several proofs of such volcanic or subterranean force. In the direction of the causeway, which, at low water, joins Taylor's Island to the main and of St. Mary's, I detected the existence of a trachytic vein about twelve feet wide, crossed by joints in the granite running south-west by south. On each side of this dyke the granite is altered in character, and, from being of the white coarse character so common in this island, assumes a brownish, speckled, and porphyritic nature. I imagine that the heat occasioned by the irruption of this trachytic vein has fused the surrounding granite, or in some way altered the character of its constituents,* causing them to re-arrange themselves in a different form; for the granite upon Taylor's Island is found to contain crystals of tourmaline replacing the mica. The dyke probably extends a good way inland, as I noticed, at a deep well, cut in the rocks, near Newford Down, that such porphyritic granite seemed to abound about all those parts; indeed, the blocks lying in all directions, do not at first sight present the appearance of granite at all; and it requires a close inspection to be assured that they are really granite.

On the north side of Porthloo Bay, likewise at low water, I found portions of a porphyritic ridge running parallel with the line of coast, stretching out to Newford Island, at north-west by west. But by far the most interesting relic of igneous action is to be found in the porphyritic dyke, or elvan-course, in Watermill Bay, near New Quay, to the north-east of the island. Attention was called, in one of the earliest volumes of the Transactions of the Geological Society of Cornwall, to this remarkable geological feature, in a paper entitled "The Geology of some parts of Cornwall and the Scilly Isles." The writer expresses therein his belief that the mass of surrounding granite was "decidedly stratified;" and, so far as mere appearances are concerned, any unscientific observer would readily concur in such an opinion. Mr. Joseph Carne, in the able paper to which I have already made allusion, thus adverts to this interesting phenomenon. "At Watermill Bay in St. Mary's, the pebbles on the beach indicate the contiguity of porphyry and porphyritic granite; and on the south side of it, between the rivulet and the curious little quay called New Quay, there is what has been called by some an elvan-course, and by others a mass of decidedly stratified granite. This is of considerable length, and rises above the granite adjoining it on each side, and seems to lie in thick beds, subdivided into smaller strata, and dipping at a large angle about north-north-west. It is decidedly porphyry, with small crystals of quartz and felspar. The adjoining granite has likewise the same stratified appearance. The question is, whether the lines of division of the apparent strata are joints, or whether the whole has a slaty structure. The former appears to me the most probable."

---

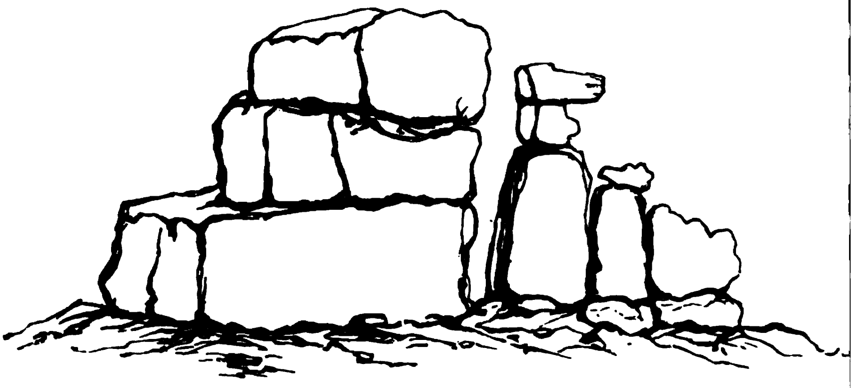
* The constituents of Felspar are, according to Rose, silica 65.91, alumina 21.00, lime or magnesia 0.11, potash 10.18, or soda 3.50. Those of Tourmaline, according to Rammelsberg, silica 37.80, lime or magnesia 1.42, alumina 30.56, soda 2.09, iron 0.50, or manganese 2.50, other substances 9.90. The iron might be procured from the mica, which contains from 4.56 to 27.06 of that metal, according to the analysis of Kobell and Turner.



Lign. 3.—Porphyritic Dyke or Elvan-course, at Watermill Bay, St. Mary's, Scilly; visible only at low-water.

The shaded portion, *a*, *b*, *c*, represents the ridge of porphyry, of lemon-yellow colour at *a*, or near the sea; red at *b*; and black near the cliffs, at *c*; *e* and *f* are ridges of granite, inclined at an angle of about 45 degrees, and apparently stratified.

Mr. Carne does not enter into any argument to show why he considers that the apparently slaty structure of the granite contiguous to this porphyritic ridge is due to joints in the rock itself; but I think it will be obvious to any careful geologist that this must be the case, when he considers this simple fact of the false stratification being confined to the granite in the immediate neighbourhood of the porphyry; and, secondly, that this appearance is equally visible on both sides of the erupted mass. The whole question of the origin of joints in the granite is one of a most interesting character; and I believe few localities will be found capable of throwing more light upon the subject than this. Mr. J. Henwood, C.E., has brought a vast amount of industry and experience to the task of unravelling the mystery, in his admirable reports upon the "Metalliferous Deposits of Cornwall and Devon," read before the Royal Geological Society of Cornwall, between 1830 and 1836, and subsequently published in a separate volume. He, as well as Mr. Carne, has shown, that though these cracks or joints seem at first sight to run in a variety of directions, they are found, upon more careful examination, to be reducible, in most granitic districts, to three distinct classes; viz. 1. horizontal, or parallel with the grain of the rock; 2. vertical or perpendicular, having generally a direction north-north-west and south-south-east; and, 3. vertical, but having a direction from east and west to east-north-east and west-south-west. In Mr. Henwood's report, a tabulated view is given of the directions of the joints in the different mines which came under his inspection; but, if I mistake not, no comparison is attempted to be drawn with the respective lines of the elvan-courses, nor of any indications of the lines of igneous action, which may have been presented in the mines. Now, I cannot but think it probable that, as in the case before us, if the course of the erupted igneous matter were previously ascertained, some decided connexion would be discovered between those lines and the direction of the joints in the surrounding granite. For what is more consonant to reason, than that the heated matter which has at one time pushed its way upwards, either filling some existing cavity in the granite, or thrusting it aside in its upward course, should so fuse and melt that rock, or so thoroughly charge it with heat, as in cooling it would possess a tendency to crack in some definite direction and according to some definite law? It is obvious that, if this were at any time the case, the joints or cracks, in whatever direction they might be, whether parallel to the line of the heated matter, or at right angles to it, would all have a tendency to run the same way; and, thus, when decomposition subsequently commenced, and portions of the rock began to break away in fragments along the line of joints, an *appearance* of stratification would, in the course of time, be brought about, just as we might produce the same appearance in an ordinary brick-kiln, by removing tiers of bricks in regular order, and leaving others standing in an inclined but orderly succession. I do not know whether I shall by this simple illustration render my meaning clear, but I cannot help thinking that, in the case of the porphyritic ridge of Watermill Bay, the "decidedly stratified" appearance of the granite is entirely due to some such action. The granite has, in all probability, at some distant time covered the porphyry, but, having been thoroughly cracked or jointed in one given direction by cooling, after having been heated by contiguity with the erupted mass, it has become liable to split into blocks formed by the transverse sections of the joints themselves; and these blocks having been removed by the action of the waves, which cover the whole reef at high water, the porphyry has become exposed to view, and being harder than the granite has resisted the force of the water, while the granite has been, not exactly worn, but gradually split in such a manner as now to lie in ledges against the porphyritic ridge, presenting the curious and unusual appearance which I have attempted to describe. This undoubted action of the elements upon the granite in other parts of the island has produced some curious results; but I fear the length to which my remarks have already led me will scarcely allow of my doing more than briefly to advert to them. At Peninnis Head, at Giant's Castle, at Old Town Porth, at the Pulpit, and Clapper Rocks, and at various other places in St. Mary's, admirable examples occur of almost columnar structure brought about by the wearing away of the granite in the direction of the vertical or transverse joints. Some of these are on a most magnificent scale. The Pulpit Rock affords an example of one large mass of granite, estimated at 40 feet long, poised in a projecting position like the sounding-board of a pulpit, and maintained in its place by a large mass of disk-like rock at the base, and effected entirely by the operation of natural causes. At Porth Hellick—the reputed spot at which the



Lign. 4.—Granite Blocks at Porth Hellick.

body of Sir Cloudesley Shovel was washed ashore, after the dreadful wreck of the "Association" and two other vessels on the 22nd Oct., 1705, when between 1,500 and 2,000 men perished miserably—there is a remarkable group of rocks. As if to commemorate this terrible disaster, one of the piles of granite has become so curiously worn as to present a rude resemblance to the shipwrecked admiral, conspicuous as he was for the use of that peculiar triangular hat which is still called after his name. To a lively imagination the mass of stone in the adjoining block may present some resemblance to the admiral's favourite dog, which he carried continually with him, and which perished with him in the wreck. There are many other highly interesting masses of granite in the several islands, which afford curious configurations from the degradation or decomposition of the rock from atmospheric or other causes. The Logan Stone on the ledge beneath Giant's Castle, for example; or the Tooth Rock, near Peninnis Head; or the Kettle and Pans, near the same locality, which might afford us some convincing arguments against the theory of Druidical rock-basins. The curious caverns, too, which exist in these islands, as, for instance, Piper's Hole in St. Mary's, with its roof of supposed regenerated granite, having blocks or boulders imbedded in it, and the singular occurrence of red alternating with white granite, may induce some more competent geologists than myself to visit this interesting locality, and to increase our knowledge of the curious phenomena which these islands present to the careful student of the wonders of nature.

THE GEOLOGY OF HOOK POINT.

By Professor R. Harkness, F.R.S. F.G.S.

There is something about the margins of Ireland, as seen on a map, and even more so when these margins are visited, which gives to this island a peculiar rugged aspect. Its northern, western, and southern sides are penetrated by deep bays, and cut into prominent headlands by the force of the waves of the Atlantic; and this erosive power of the ocean has not only added much to the boldness and beauty of its coasts, but has also revealed to us much information concerning its physical structure, and the conditions under which many of its rocky masses were formed.

Among the many promontories which stand out to tell us of the destructive operations of the restless sea, is one which forms the western extremity of the county of Wexford, and which is known as Hook Point. This has its records of history in connexion with the state and condition of Ireland at a period when that country first became the permanent abode of the Saxon.

A short distance eastward from Hook lies Bag-un-brun, the spot on which the Normans first trod in Ireland, when 1,300 English, led by Strongbow, arrived to assist and foster those international quarrels which rendered that country an easy conquest for its foreign foe.

Hook Point has, however, a more ancient record to reveal—a history of a state of things long antecedent to the period ere Ireland's

> "Faithless sons had betrayed her."

In its stony bosom, torn and lacerated by the angry waves, is written the history of circumstances and conditions which existed at a time, not only long previous to the English invasion, but antecedent to the existence of the human race on the surface of the globe,—even anterior to the time when many of those lands which are now the abode of the human family were elevated from the bosom of their parent ocean. The stony hieroglyphics of Hook Point speak to us of a period so far back in the abyss of Time, that if we contrast this period with that of other rocky records, we can only arrive at the conclusion, that long ere the heads of the Alps or the Himalayas were lifted up, the stony matter of Hook was formed, and had the arrangement which it now exhibits to us.

Its rocks are older than the great mass of rocks which afford the food of the steam-engine,—man's great organ of progress,—and they equal in antiquity the hard grey limestones of the north of England, which support the coal-bearing beds of that region.

Hook Point is a spot of much geological interest, and the limestones of which, in a great measure, it consists are perfect charnel-houses of solid skeletons of beings which existed in an ancient sea.

Although Hook Point is composed of strata which are known to the geologist under the name of the Carboniferous Limestone, these are not the only rocks which enter into the composition of the promontory terminating in this headland. The whole of the geology in connexion with this portion of the county of Wexford is of great interest, and tells of circumstances and agencies which produced different results, as these several conditions and agencies differed from each other. The structure of the great mass of the county of Wexford consists of rocky strata, which are designated Lower Silurian, and which are equivalent, in geological age, with the great mass of rocks forming the mountainous range traversing Scotland from north-north-east to south-south-west, south of the Forth and Clyde, and which is now known under the general name of the Southern Highlands of Scotland. Wales, too, has rocks which occupy the same geological position; and from the circumstance that these rocks are well developed in the neighbourhood of the town of Llandeilo, the illustrious author of the Silurian System has given them the name of Llandeilo-flags. In the south of Ireland these Lower Silurian rocks consist not only of deposits such as emanate from the ordinary action of marine causes, but they have, associated with the usual products of aqueous action, beds of ashes resulting from the matter evolved from ancient volcanos, which were in active operation at that remote geological epoch; and these volcanic ashes, falling upon the surface of the ancient sea, were sifted and arranged, and finally deposited among shells and corals, imbedding these animal remains often in particles which retain, to a great extent, their original crystalline form, as the ash of felspathic lava. None of these ancient ashes enter into the structure of the promontory of which Hook Point forms the southern termination, although they approach very nearly thereto. The mass of rocky strata which more properly appertains to Hook has an age much more recent, and the older rocks have undergone not only consolidation, but have been subjected to the action of violent subterranean forces, which have bent, twisted, and elevated the older masses, long previous to the period when the conditions prevailed which gave rise to these newer rocks which make up the headland of Hook. Those more ancient rocks have to a considerable extent furnished the materials out of which a portion of the Hook promontory was constructed, and they afford evidence that, after the twistings and elevations referred to, a portion of their area formed the margins of the sea from whence resulted the rocky masses which more immediately support the Carboniferous limestones of Hook Point. The western side of Hook, at a small bay near the village of Templetown, among the rocks of the coast, gives us an insight into the physical causes which were the prelude to those conditions from which the limestones, rich in organic remains, emanated. Here we find coarse sandstones, and sometimes there are what are known to geologists under the name of conglomerates, consisting of rounded pebbles cemented together by a sandstone-base, and recording in their structure the fact of their having been originally fragments broken by the action of ancient waves from previously existing rocky coasts, and afterwards ground upon each other, each one rubbing from its neighbour its angularity and asperities in the same manner that we find, at the present time, the sea-margins of even rocky coast fringed by an outline of pebbly beach, the result of the force and abrading power of the ever-restless ocean.

These conditions of an agitated sea, preceding the formation of the newer and overlying rocks, were succeeded by features of a more tranquil nature, with respect to the ancient physical geography of this portion of Ireland. The sandstones became gradually less coarse; and in the strata which are intermediate between the conglomerates below and the limestones above, traces of organic beings begin to make their appearance. These consist of fragments of land-plants, having a coaly aspect, and, on the whole, indistinct as to their characters. They bear about them sufficient evidence to show that they formerly flourished on the surface of the earth as the stems of ferns; and from their nature and geological position, there is strong reason for concluding that they are the relics of that form of fern which is so abundant in rocks of the same age in the county of Kilkenny—the *Cyclopteris Hibernica* of the late Professor E. Forbes,—a fern which also makes its appearance among contemporaneous strata in the county of Berwickshire, at Prestonhaugh, near Dunse, associated with a *Pterichthys*—one of the fossil fish so well described by the late Hugh Miller.

In Ireland, however, this fern has no such companion in its burial. In Kilkenny we, however, find it associated with a bivalve-shell (the *Anodon Jukesii*) of such a character as to lead to the inference that in some localities fresh-water lakes exerted some influence in the production of these sandstones antecedent to the period of the Carboniferous limestones.

These sandstones, and their associated conglomerates, bear about them features which indicate that they have been subjected to violent forces since they were deposited, and even subsequent to their consolidation. These are very beautifully marked by the phenomena known to geologists under the name of jointing; and these phenomena are nowhere better exhibited than in the district about Hook Point. These joints consist of divisional planes, which in this locality are for the most part perpendicular, and run in nearly a north and south direction. These planes not only separate the masses of rock into distinct portions, but they also exhibit themselves in the form of narrow openings, which seem to have resulted either from a rigid mass breaking itself up into distinct portions in consequence of great pressure, or from each separate portion—included between two joints —so shrinking as to leave intervals arranged in such a manner that these intervals shall be nearly constant and uniform in their course. There is about these joints which intersect the conglomerates a feature of great interest; and this feature is not confined to the country about Hook, but likewise manifests itself in many other localities where we have jointed conglomerates. The quartz-pebbles which enter largely into the structure of these conglomerates, have been cut through by the force which has produced these joints in such a manner as to exhibit regular smooth faces, as perfect and uniform as the faces of an apple when cut through by a knife. There are so many features in connexion with jointing in general, and so many phenomena of a complex character, that of all geological problems, jointing is about the most difficult to render a satisfactory account of or to find a solution for. Pressure and shrinkage are the two causes to which these phenomena have been attributed, and the influence of the former seems to have been that by means of which we can best explain the features manifested by this portion of the physical geology of Hook.

(*To be continued.*)

FOREIGN CORRESPONDENCE.

By Dr. T. L. Phipson of Paris.

Recent Earthquake at Lisbon—Another Earthquake at Biarritz—M. Lejeune's "Lectures on the Geology of France"—A generalization by Alexander Von Humboldt—A word by Georges Cuvier—Burning Coal-pits of l'Aveyron—Formation of Alum—Salt-basins of l'Hérault—Waterfall of Gavarnie—A passage from the "Views of Nature"—French Kaolin—Death and Writings of Madame Ida Pfeiffer—Submarine Volcano near Leghorn—Supposed vertebrate remains in the Silurian Strata.

An earthquake took place at a quarter past seven and at nine in the morning of the 11th of November last, in Lisbon and some of the provincial towns of Portugal. The first shock, which some accounts divide into two distinct ones, lasted fully half a minute, and shook every house in Lisbon; the vibrations of the soil were apparently in a north-south direction. This is said to have been the most violent earthquake experienced in Lisbon since the great one of 1755, and very little more vibration could not have failed to produce the most disastrous consequences. Many chimneys fell, and walls were thrown down or cracked; but it is said that no building was destroyed completely, although one death was caused by the falling of a half-built wall at the École Polytechnique. At Villa Franca another death occurred, and at Cintra and Mafra a good deal of injury was done to the houses. But of all the accounts hitherto received, those from St. Ubes, about eight leagues from Lisbon, on the south side of the mouth of the Tagus, are the most distressing. A great number of houses were thrown down, and some of the inhabitants were buried in the ruins.

This earthquake was preceded by two days of almost incessant rain.

M. de Monfort has addressed a letter to the Abbé Moigno, editor of *Le Cosmos*, describing an earthquake, the first he ever witnessed, felt at Biarritz on the 29th of November last:—At about one o'clock in the afternoon, a dark fog floated heavily in the air, giving to the horizon an unusual tint that made M. de Monfort suppose that something extraordinary was about to happen. Indeed, he was so influenced by the existing state of things that he actually spoke of earthquakes to some persons present. His head felt heavy and weary, and he quitted his office quite overcome. A Réaumur thermometer marked fifteen degrees and a half. The sea was furious and of a grey colour, and M. de Monfort's dog had hidden himself under a bed. Two sheep that were grazing in a court-yard escaped and hid themselves.

It was ten minutes to one when, standing up in the middle of his room, he felt the floor moving, and perceived the objects on the table in motion also. He was immediately aware that it was an earthquake, and saw distinctly the oscillatory motion of his house, by comparing the level of his window-ledge with that of the sea. These oscillations may have lasted about four or five seconds, and took place very regularly in a north-south direction. M. de Monfort counted three of them. The direction of these oscillations was observed likewise by all of whom he inquired concerning them. It was moreover indicated by objects hanging from the ceilings of the dining-room and kitchen; they continued to oscillate five minutes or more after the phenomenon had ceased. An hour afterwards the dark fog had disappeared, and the sun's rays darted down with all the fierce heat of an August day, although the thermometer had not varied. A storm-cloud then darkened the heavens; its electricity was dissipated by a few lightning flashes and a little thunder. M. de Monfort did not learn that this earthquake was accompanied by any damage to habitations.

The detail of this account renders it very interesting. The Abbé Moigno adds to this letter, from the accounts given by various French papers, that the phenomena observed by M. de Monfort at Biarritz had also been remarked at Bayonne, Anglez, and Saint-Palais:—"In several other places doors were slammed, persons were knocked down, a shepherd saw the animals in his flock lifted up; the fruit of the cypress tree moved on the ground as if agitated by a violent wind. At a place called Saint-Jean-Pied-de-Port some tiles were detached from a roof, a chimney fell, strong beams were heard to crack with much noise, furniture and clocks were put into violent motion. The oscillations of the ground seemed to be accompanied by a deafening noise; people walking stumbled as if the ground was taken suddenly from under their feet."

A small work has just appeared in France, entitled "*Lectures sur la Géologie de la France*," together with another, taken from the first, entitled "*Lectures sur les Pyrénées*." The author, M. Lejeune, has published the first of these with a view of popularizing the study of Geology in his native country. It is composed of a series of lectures delivered by him to a Literary Society (now no longer existing), and he has found it necessary every now and then to pass beyond the limits of the country in which he is more particularly interested, in order to render his lectures more interesting and agreeable. The other volume is a *brochure* treating only of the Pyrenees; it is extracted from the former work, and is destined for the use or amusement of the numerous strangers who visit these remarkable mountains.

In publishing his *Lectures on the Geology of France*, M. Lejeune does not pretend to have produced a book from his personal investigations, but a work compiled from the best authorities, in which, however, the author has been able to add, here and there, details of his own.

It is now established beyond a doubt, that it is impossible to have even a mediocre knowledge of any country, without being to a certain extent a geologist. It is many years since Alexander von Humboldt, in some of his admirable writings, made us familiar with the fact, that, throughout Nature, rocks alone show themselves identical in each hemisphere, in every latitude. Passing from one climate to another, we see, for instance, birch-trees, oaks, and maples, give place to palm-trees, opuntias, and bamboos; deer, rabbits, and wolves, to camels, lions, elephants, &c.; whilst granite is granite in every clime; amphibole, porphyry, and basalt are found to be identical from one pole to the other; sand, clay, and limestone are everywhere similar.

Georges Cuvier, however, said one day, and with much truth, that every mineral has its use, and upon its greater or less abundance in such or such a place, or upon the greater or less facility with which it can be extracted, often depends the prosperity of a nation, its progress in civilization, and the whole detail of its manners and customs. This is certainly saying enough of the importance of Geology and Mineralogy; and we perceive that these beautiful sciences, so intimately connected with Chemistry and Physics, attract more and more each day the attention of the admirers of Nature.

But to return to M. Lejeune. His book is not divided into very characteristic sections, except that he passes in succession from one geological *massif* of France to another. It is rather a series of chapters, written simply and clearly, each of which constitutes an interesting excursion into some French province, or into some neighbouring country. We will analyse a few passages:—

In speaking of l'Aveyron, our author relates that this part of France, bordering on the volcanic formations of Auvergne, presents to us, not ancient volcanos which once upon a time vomited floods of lava, but hills of Coal-formation, where, some centuries ago, damp air and spring-water occasioned the phenomenon of spontaneous combustion, which continues to the present day. This combustion, kept up by the chemical change going on in the decomposition of iron-pyrites, the formation of sulphate of iron, sulphate of alumina, &c. "produces crystals of alum in such quantity as would supply with this substance the entire wants of French industry."* The conflagration going on in these Coal-beds is hardly perceptible in the day-time; but in the darkness of night one sees many little craters throwing up volumes of vapour, the production of which is maintained by the water that constantly filters through the soil. The people living near one of these hills, hoping to extinguish the combustion, directed to the place all the little rivulets of the neighbourhood; but, instead of producing the desired effect, the water of the streams augmented its intensity to such a degree, that every one feared an explosion would have taken place.

---

* The alum thus produced is no doubt iron-alum, *i.e.* sulphate of iron and alumina,—T. L. P.

A little further on, we have a description of the *Salines de l'Hérault*, or Salt-basins of Hérault. They are large quadrangular basins, in depth a few inches below the level of the sea, and surrounded by banks to retain the sea-water. The latter enters at high tide, by an opening which is then immediately closed, and a little fresh water is added from the neighbouring springs. By evaporation, the salt is deposited in thin crusts, and, as fast as these form, new supplies of salt water are allowed to enter. When a layer of salt some 27 or 33 centimètres in thickness has been obtained, it is taken out and piled up into triangular heaps, which are covered with grass, rushes, &c. and allowed to dry, whilst awaiting exportation.

The following is given by M. Lejeune concerning the falls of Gavarnie :—"In the Hautes Pyrénées, the cascade of Gavarnie is fed by the perpetual snows which cover the summit of a circular wall of rock, having a vertical height of 389 mètres. This circle is so vast, and the purity of the air in mountainous districts is so adverse to the just appreciation of distances, that being placed one day near the falls, I perceived something on the opposite side of the semicircle of rocky wall, that appeared to be a fly about to crawl over. . . . This fly turned out to be a smuggler on his way to the *brèche de Roland*."—Here is something similar in the charming *Views of Nature* of Baron Von Humboldt :—"The transparency of mountain air is so great near the equator, that, in the province of Quito, I was able to distinguish without the aid of a telescope the white cloak (*poncho*) of a gentleman at a horizontal distance of 84,132 feet. . . . It was my friend, M. Bonpland, who had just left the charming villa of the Marquis de Solvalègre, and was walking along the dark-coloured sides of the volcano of Pichincha."

The decomposition of certain varieties of Granite, and above all of Pegmatite in the central mountains of France, has produced many different qualities of *Kaolin*, so extensively used in the manufacture of porcelain. M. Lejeune informs us that the white Kaolin of Saint-Yrieux, near Limoges, notwithstanding the great variety of rocks accumulated as it were in this district, is extremely pure. It is found to extend in a bed many kilomètres long, and sometimes is seen penetrating the rocks, like lodes or veins, attaining here and there twenty mètres in thickness. This bed of Kaolin has supplied the porcelain-manufactory of Sèvres since the year 1765, and not only furnishes the best material to all the china-manufactories of Paris, but is even sent out to the United States of America.

In passing near the town of Limoges, our author has evidently forgotten to pick up a specimen of the common variety of Emerald which serves to pave the coach-road from that town in the direction of Paris. We will terminate here what we had to say of his book. It is written in a lively style, and is one which will contribute to inspire a taste for Geology, at the same time giving its readers a desire to consult works of a higher order; and, if we mistake not, such has been the author's intention.

We are grieved to learn the death of the celebrated traveller, Madame Ida Pfeiffer, who has been known for some time to our English readers by her "*Visit to Iceland*," "*The Scandinavian North*," "*Travels in the Holy Land, Egypt and Italy*," or perhaps better still by "*A Woman's Journey round the World*, and "*A Woman's Second Journey round the World*." The writings of the late Madame Ida Pfeiffer are more adapted for the general reader than the scientific world. She appears to have travelled from pure curiosity to see the different places she has visited, and her works are naturally of a very interesting character. It is rarely that she speaks of the geological formations of the numerous spots on which her feet have trod, though in her "*Visit to Iceland*," for instance, she speaks of what she saw at the Geysers, without, however, bringing away any new scientific fact. Here is a passage from her work entitled "*A Woman's Journey round the World*," which is not uninteresting in a mineralogical sense, and which will perhaps give an idea of her style of writing. Speaking of the environs of Valparaiso, she says:—"Persons discovering mines are highly favoured, and have full right of property to their discovery, being obliged only to notify the same to the government. This license is pushed to such an extent, that if, for instance, a person can advance any plausible grounds for asserting that he has found a mine under a church, or a house, &c. he is at liberty to have either pulled down provided he is rich enough to pay for the damage. About fifteen years ago a donkey-driver accidentally hit upon a productive silver-mine. He was driving several asses over the mountain when one of them ran away. He seized a stone and was about to throw it after the animal, but stumbled and fell to the ground, while the stone escaped from his grasp and rolled away. Rising in a great passion, he snatched up a second stone, and had stretched his arm to throw it, when he was surprised by its enormous weight. He looked at it more closely, and perceived that it was streaked with veins of pure silver. He preserved the stone as a treasure, marked the spot, drove his asses home, and then communicated his discovery to one of his friends who was a miner. . . . In a few years both were rich men."

But, to return to Geology.—At Leghorn, recently, a thick smoke was perceived to arise from the water in the new port, and it was feared that a vessel was on fire; it turned out, however, that it was occasioned by a submarine volcano, and the authorities deemed it advisable to remove at once the gunpowder magazine to a distance. We hope to receive more news of this by and by.

In one of the recent meetings of the *Academy of Sciences*, at Paris, M. Marie Rouault called attention to what he supposed to be the remains of some vertebrate animals from the Silurian schists of St. Leonhard in Brittany. M. de Verneuil, having subsequently visited the locality, has obtained several of these fossils, called "eels" by the quarrymen, and finds that they are merely pyritous casts of fucoidal bodies. On this visit he discovered that these Silurian slaty schists are underlaid by a Lingula-bearing sandstone, of probably the same age as the Potsdam sandstone of North America, and the Lingula-flags of Wales.

NOTES AND QUERIES.

COMMUNICATIONS FROM COLONISTS.—"In a community so small, so occupied with business, and in general so destitute of all taste for science, as a colonial town, where there are no men who combine the leisure and means with the inclination to foster scientific inquiries, it is all up-hill work to the amateur in science. He has no one to sympathize with and assist him in his difficulties, nor to share his triumph in success; while, if engaged in professional duties, the public regard the time spent in his scientific pursuits as worse than wasted. I have always observed the public are more tolerant of cards or billiards than of Geology or Botany. The appreciation of our labours at home is the only reward we can look forward to. The colonial public is profoundly ignorant of and indifferent to science: I wish much that some means could be devised by which such questions as those we wish to submit to special Geologists, could be answered by eminent men, without directly troubling them with letters, which I am quite sensible must be a great and unjustifiable tax on their valuable time. Many difficulties beset the early progress of the colonial Geologist in his science, which he has no means of getting over but by referring to Europe; and he is often too straitened in means to afford to pay for an analysis. Some years ago, a lengthy dispute, as to whether a given rock was igneous or aqueous, was terminated by sending home a specimen of it, which was pronounced to be oxide of iron and quartz. In this case, certainly, the disputants ought to have settled their argument by an appeal to the blowpipe; but there are many cases in which the authority of eminent gentlemen of the scientific Societies at home would clear up difficulties, and encourage to further exertions. As I said before, men at home work with hope that their labours will lead to distinction; here we have none to appreciate our researches. Now, apropos of the trouble, on the one hand, to eminent men of science, of questions on Geology and Mineralogy, and on the other desirableness of smoothing difficulties to tyros in science, by appeal to authorities at home, I should be glad to know if there be any way of asking these questions without unnecessary trouble and inconvenience to those whose time is of so much value to themselves and to the scientific world in general. If not, and if any plan could be devised for instituting a corresponding secretary through whom information could be obtained, I am sure there must be many who, in common with myself, would be most happy to contribute towards the expenses attending such an institution. I fear such a suggestion may appear presumptuous from so obscure a collector as myself; but I have so long wished to hear of fossils, &c., I have sent home (some ten years at least), and the information could, perhaps, have been given so easily by some members of the Geological or other such Society, that I have often wished for some such means of asking a question or two. One forgets and loses interest in specimens after lapse of years.—AN ANTIPODEAN COLONIST."—It is with sincere pleasure that we put our pages at the disposal of our countrymen in far distant lands: and the attention which we have already offered to give, and, in very numerous cases have given, to the specimens forwarded to us from our correspondents in the British Isles, we will, with equal readiness, extend to those forwarded us from any region, however remote, which the adventurous traveller or geologist might chance to visit or to reside in. We think, moreover, that this magazine would prove a valuable source for obtaining such knowledge and information as our colonial correspondent desires, through the facility with which questions could thus be brought before hundreds of readers, and a greater amount of instruction would, by these means, be received than in ordinary course could be expected from any specially appointed secretary or other officer. At all events, we lay ourselves open for receipt of foreign or colonial communications, and for the examination and notice of such foreign and colonial fossils and specimens of rocks and minerals, &c., as may be transmitted to us carriage-free, holding such specimens at the direction of the proprietors, or disposing of the same in any inexpensive manner.

PROTEST AGAINST THE USE OF INITIALS BY CORRESPONDENTS.—"I eagerly look for the GEOLOGIST as the first of each month comes round; and I heartily wish it success. To me, however, and I doubt not to more of your readers, the interest and usefulness of the work is lessened by the number of minor communications which appear under anonymous signatures. Periodicals of this class effect one most important purpose—that of making known the 'whereabouts' of local workers in Geology, and thereby enabling persons to come into mutual communication who might otherwise never have heard of one another. But the system of *initial-signature* shuts the door against all this. To take a case in point;—one of your early numbers contains a communication from a Correspondent at Harwich, writing for some local information, but having appended to it simply his initials. Now, I am particularly interested in the Geology of Harwich, and most anxious for correspondents in that district. Had the writer in this case given his name, I dare say I could have been of service to him, and most likely he in return might have helped me. When I became, in 1837, proprietor of Mr. Loudon's well known Magazine of Natural History, I found no difficulty in abolishing the initial system, except in certain cases; for every now and then there may be reasonable grounds for writing *incog.* Of the inconvenience which may result from it, the case of your Bristol correspondent, Mr. Higgins, who offered to exchange inferior Oolite Fossils, is a notable example. EDWARD CHARLESWORTH, York."—While we agree with Mr. Charlesworth as to the desirableness of correspondents writing under their proper names, we also think it would not be right of us to insist upon this point. Many of the questions in our "Notes and Queries" department are without doubt very modestly asked, and yet, while they are really highly useful to other students and beginners in the science, they are not uncommonly of such a simple character that many who ask them would be unwilling to put them publicly in their own names. To our principal articles the names of the writers are always put, unless we are expressly enjoined *not* to print them. We think, however, that our correspondents should enclose their cards with these anonymous communications, that we might individually, in our capacity of Editor, be enabled, with the concurrence of the respective parties, to place them in communication with each other where desirable. It seems to us, moreover, that when geologists, as in Mr. Charlesworth's case, desire further communication with any particular correspondent writing anonymously, or under an initial, they might intimate their wishes in another number of this Magazine, or offer certain services, as was so kindly done by Mr. Sanders of Bristol, in reply to W. S. (Vol. I. p. 161). We desire to make this journal as useful as possible; but the number of communications we receive, of an anonymous character, evidently attests the existence of a feeling of a very general character. In respect to the "Notes" themselves, we concur to the fullest extent in the real advantage of the author's name being attached; the fact of a note being printed at all in this journal suffices to acknowledge its worth, and the suppression of the name of the person responsible for the fact stated is not just to Science.

PHYSICAL GEOLOGY OF WEARDALE.—"DEAR SIR,—I am living on the Carboniferous Formation, in a narrow valley cut down from the Millstone-grit to the Basalt, the depth of the valley being several hundred feet; and, as I am a most ardent admirer of Geology—in which science, however, I am only a tyro—I have been led away often into a train of speculations seeking for a solution as to the character of the forces that excavated this channel. I soon perceived that water was the only agent; but how was it employed? Was it by the present stream, by oceanic currents during submersion, or by the abrasion of waves when the sea stood at a higher level than at present, or by all these agencies at different epochs collectively? It appears pretty evident that this locality was submerged during the Glacial Epoch, as I find in several places a great thickness of blue clay, intermixed with smooth, water-worn, and striated boulders. The river, which runs in a south-easterly direction, would be unfavourable for the deposition of sediment during the drift-period; and such I find to be the case; in fact, the currents coming from the north would tend to wear the channel deeper; whereas, in the case of the rivulets that run into the river at right angles to its course, there is a large deposit of clay and boulders on their *north or sheltered sides.* I also send you some specimens broken from a block of Scotch Granite, as I suppose it to be, which I picked up in this district. The boulder weighs several pounds, and, if I am correct, must have been floated hither on an ice-raft from Scotland, when our fine romantic dale was covered with water! We have no Granite like this in the north of England that I know of; Shap Fell Granite being of a very different kind. Such are my opinions; and such are my queries; I now ask your assistance and advice. I think your answers to the above would much interest many readers of the GEOLOGIST beside myself.—Dear Sir, yours truly, J. ELLIOTT.—Weardale, Durham."—Our correspondent's inquiries are legitimate and well directed; and we hope that some day *everybody* will be sufficiently enlightened to trouble themselves with similar questions as to the physical features of the localities where they live, and in time sufficiently conversant with the principles of Geology from their very school-days, to recognize the chief reasons for the contours and structure of the hills and valleys around them. The valleys have usually originated in cracks or faults in the strata, consequent on some more or less extensive general crust-movement of the area when beneath the sea. As the ground rose, the action of the waves of the advancing shore-line widened the fissure, sometimes sweeping away the *débris*, and sometimes leaving it as gravel and sand; and made it a creek, estuary, or bay—with perhaps an extensive system of minor fissures forming drainage-valleys leading into it. Subsequently, when the land was at a still higher level, the streams and rivers followed this hollow, excavating channels in the higher parts of the valleys, but filling up the lower parts with new gravel, sand, and silt. The rain and other atmospheric agents have also ceaselessly worked to modify the sides of the valleys. The application of this theory of the formation and modification of valleys to individual instances must be left to local experience. Doubtless our correspondent is correct as to the ice-carriage of the granitic boulder (a Granite with black mica).

THE GEOLOGISTS' ASSOCIATION.—There has been felt, for some time, much need of a common means of intercommunication among those who, while not devoting their lives to the pursuit, yet take an active interest in the facts and teachings of Geology. The "Geological Society" is too far advanced in the strict course of scientific method and treatment to be found available by the increasing numbers of those who desire modestly to seek mutual help as learners, but shrink from the assumption of ranking themselves among the illustrious professors and masters in the science. To meet this want, a number of gentlemen have organized themselves into a *Geologists' Association*, having for its special purpose the providing those means of intercommunication and mutual help. It is proposed to hold regular meetings; to form a museum of typical specimens; to afford facilities for the collection and exchange of specimens, and for rectifying doubtfully named ones; to communicate information as to the best methods of search, localities, &c. which the experience of members may enable them to interchange; and, in general, to enable the practical student in Geology to find a congenial place where doubts may be stated and experience exchanged,—and so the pursuit of this interesting and invaluable branch of inquiry be made at once pleasanter, and freed from some of the difficulties which now attend the pursuit of it both by individuals and localized institutions. The Association will embrace members both in town and country; its objects and usefulness being equally available by those in either, with the exception, in the latter case, of the general opportunities of personal attendance at the meetings. The subscriptions have been fixed purposely, and with deliberate consideration, at a rate which will exclude none from the benefits it can give. The subscription for town members is *ten shillings* a-year; for country members, *five shillings* a-year. All members will be entitled to copies of whatever printed minutes of the proceedings of the Association are issued. The first meeting of the Association for business, will be held on an early day in January, which will be duly announced to subscribers, and when an inaugural address will be delivered by the Chairman.

Chalk Sponges of Yorkshire.—"Sir,—I think a paper, accompanied by sketches, of the sponges from the chalk of Flamborough Head, would be very acceptable to many of your readers. I do not find them described in any of the popular books, although probably they are to be found figured in some of the works on Yorkshire.—Yours, &c., X. Y."

Mammalian Remains near Wells.—"Sir,—Seeing in one of your magazines of this year a request that Geologists would furnish you with the localities where the remains of mammals have been observed in the provinces, I beg to inform your readers that I found several teeth of Rhinoceros and of Elephants on the side of the Mendip Hills, about two miles from the city of Wells, and close to the celebrated Wokey Hole cavern; they were about fifteen feet below the surface, in a conglomerate resting on the dolomite limestone.—Yours, &c., Francis Drake, Leicester."

Manner of cutting Films of Selenite.—(See Vol. I. p. 444.)—"Good, large crystals of selenite can be split into laminæ of uniform thickness with a penknife: but much care is required, and many failures occur. This is the method I have always employed for my own purposes, with sufficient success.—H. C. Sorby."

Mineral-Veins.—(See Vol I. p. 450.)—"If a portion of limestone be placed in the solution of any salt of the peroxide of iron, or a salt of the protoxide exposed to the air, a deposit of the peroxide of iron is formed on the limestone. No such effect is produced by a fragment of sandstone; and, in some cases, at all events, this will, I think, explain what your correspondent refers to.—H. C. Sorby."

Mineral-Veins in Limestones and Sandstones.—"Dear Sir,—In reply to the very candid request of your correspondent, I beg to say, that the examples which have led me to arrive at the conclusion that mineral-veins, in general, contain more iron in limestone than in siliceous strata, are those afforded in the lead-mining district of the north of England; more particularly in that part of it comprising Alston Moor, Allandale, and Weardale. The lead-bearing strata in these localities are of the mountain-limestone series, and consist of alternating members of calcareous, siliceous, and argillaceous characters. Interstratified with these beds is one of basalt, locally called the great whin-sill, and of considerable thickness, amounting in some places to 30 or 40 fathoms, or even more. Higher up in the series is another of the same nature, which may be observed in the Wear Valley between Stanhope and Eastgate, but this seems to be of very limited extent. The great whin-sill lies at a considerable depth below the surface in Weardale, nevertheless, it has been sunk through at Pasture Grove mine, where a very productive vein is being worked. It has also been penetrated at Slit mine, near Westgate. The workings of these two mines above and below the water-drainage lay open a very considerable thickness of strata. Owing to the rise of the beds in a westerly direction, the same sills which have to be sunk into in Weardale are accessible by adits at Alston Moor. The thickness of strata from the upper surface of the great whin-sill to the top of the lead-measures is about 180 fathoms. In this space are included 10 beds of limestone, 27 of sandstone, 29 of plate, 3 of an argillo-siliceous nature, and 5 of sulphureous coal: the aggregate thickness of each set being as follows, namely, limestone 179 ft., sandstone 345 ft., plate 414 ft., argillo-siliceous beds 147 ft., and coal 5 ft. Although these strata do not maintain a perfect uniformity of thickness throughout, yet, the above may be taken as approximating to accuracy sufficiently for the present purpose. The limestones and sandstones are the chief metalliferous strata, and, in the above section, the thickness of the former to that of the latter is as 1 to 1·91, without including the siliceous in the argillo-siliceous beds. The argillaceous strata are seldom productive of lead-ore, except in some veins which carry a rider, or vein-stone, where they are said to be mineralized. Dividing the lead-measures which lie above the whin-sill into three divisions, the middle is the richest and most extensively worked. From long experience in working these mines, it has been noted as a fact, that the veins are wider in limestone than in siliceous strata. By acquired information of the numerous examples at Alston Moor in Cumberland, at the two Allendales in Northumberland, and at Weardale in Durham, coupled with my own observations, I do not hesitate to say that the quantity of iron in veins in siliceous strata is but small in comparison to the quantity in the same veins where they cut through limestone. Not only is this the case in the localities quoted, but in the adjoining mines of Teesdale the veins also seem to be of a more ferruginous nature in the limestone than in the sandstone. The most noticeable stratum is that designated the 'great limestone.' Nearly three fathoms from the top of this limestone is an argillaceous bed, called the 'black-bed,' about a foot thick. In three places of the 'great limestone,' some veins mineralize for several fathoms horizontally. These horizontal mineralizations are designated 'flats.' The distanee from the top flat, which occurs about four feet below the 'black bed,' is near two fathoms, and from the middle flat to the lower one rather more than two fathoms. The heights of these flats and their distances from the vein-fissure, which mineralizes them, vary considerably, and seem to be much influenced by the proximity of metalliferous 'strings' and of other veins. In some cases where there is a complication made by numerous crossings of veins, the flats will unite and form one mineral mass through the compact body of the limestone nearly up to the 'black-bed.' Ores of iron and lead are the chief metallic deposits. In Weardale a company is now working the lead-ore veins for iron, in the flats and at the intersections. The iron is obtained both by mining and from open cuttings; the latter affording favourable opportunities for observation, and such is the extent of the workings that hundreds of tons are sent away daily to the blast-furnaces. A siliceous bed lies close to the bottom of the limestone and other two not far above it; the barrenness of these in ferruginous matter contrasts strongly with the repletion of such matter in the limestone. It may be remarked that these siliceous beds above the limestone have yielded in the veins small quantities of crystallized carbonate of iron. The iron is also scanty in the veins in those siliceous strata more remote from the limestone. I am aware that veins in granite and siliceous schists do contain a considerable portion of iron, yet, I am disposed to think that the same veins might hold more in limestone, if such were present. In testing the soundness of the query, it is but fair to take veins cutting through limestone and siliceous strata, and, noting the thickness of each to draw thence a comparison with the contained quantities of iron. If the above examples are not satisfactorily sufficient for the solution of the question, perhaps other local observers, who have had experience of such phenomena, would be willing to give their testimony and evidence. Your correspondent states, that the presence of iron materially influences the productiveness of other valuable ores. The limestone which has just been described as being rich in iron in the veins and flats, has also been exceedingly prolific of lead-ore.—Yours, &c., J. C."

IGUANODON REMAINS AT ATHERFIELD, ISLE OF WIGHT.—"The remains of an Iguanodon have been discovered high up in the Lower Greensand deposits of Atherfield,—namely, in the sands of Cliff End. The whole of the skull with teeth was found; but, owing to the friable state of the remains, the manner in which they were imbedded, and the impatience and unskilfulness of the finders, they were got out piecemeal; many of the teeth had been sold before I heard of the discovery. I have, however, secured about a dozen, as also some fragments of the jaws and skull. The remainder of the skeleton is in the possession of the discoverer.—Yours, &c. MARK W. NORMAN, Ventnor."

DURA DEN.—YELLOW SANDSTONE AND FOSSIL FISHES.—The Rev. Dr. Anderson, of Newburgh, has again been in this celebrated locality, now of world-wide fame, and tells us he has seen more fishes taken out of the solid rock than he ever had an opportunity of seeing in any drag-net at any one time from the waters of the teeming ocean. A few workmen were engaged, and in the course of a day or two there were laid on the green sward of this lovely dell upwards of five hundred fossil fishes, raised from their marble sarcophagi—in which they have been interred for ages—all bright and fresh as the living things of yesterday. One of the slabs, about five feet square, contained nearly a hundred specimens projecting in bold relief from the surface, most of them without a scale displaced, or an organ disturbed. The fishes on another slab, upwards of fifty, were literally glistening and sparkling in their vivid armiture of bones (for the scales of these olden fishes are all true bone); and one of them in its full, plump, rounded form, looked as tempting as any Isaac Walton could desiderate in the choicest salmon of our modern rivers. This peculiarity in the Dura Den fossils is the more remarkable and noticeable, because in all our other quarries, as Clashbennie, Parkhill, Coupar-Angus, Cromarty, and elsewhere, their scales are of a dirty chalky whiteness, without tint or enamel. Strange, too, that they not only lie here in clusters and detached groups, but are confined within the range of a single stratum in at least several hundred feet of visible rock. No fragment of skeleton, bone, or scale, is discoverable anywhere throughout the mass, save in this one thin division. Speculation here for the *savans* who shall meet at Aberdeen next year. What the cause of the preservation of the enamel, of its bright tint, and above all, of the limitation of the fossil-bed? Many other curious and interesting questions will suggest themselves. Some of the slabs were taken out entire and unbroken, and are now safely deposited in the museum-rooms of Dura House; and the unrivalled collection there brought together, in these and in former researches, will henceforth form a subject for admiration and instruction to the curious and learned in geological science. The collection is all the more valuable, from the circumstance that the fish-bed is nearly run out, or thins and dips inconveniently under the great mass of superincumbent rock. The specimens obtained consist of several species of *Holoptychius*, *Dipterus*, *Platygnathus*, and the *Glypticus Dalgleisianus* (named in honour of the Dalgleish family, at the British Association in Edinburgh, 1850). A splendid specimen has been forwarded to Sir Roderick Murchison for the Museum of Economic Geology; and it is to be hoped that the noble collection at Dura House, unsurpassed in richness, variety, and preservation, will find its way to some national depository of Science as a memorial of the finest fossil-ground of the true Scottish Old Red Sandstone.

ANONYMOUS COMMUNICATIONS.—"With respect to the 'Notes and Queries' in the GEOLOGIST, I would suggest, that, considering the subjects and object of that division of your valuable magazine, it would be very desirable for writers to give their names and addresses in full.—I remain, dear Sir, yours truly, J. E. WAKEFIELD, Highgate."

CRUSTACEANS OF OLD RED SANDSTONE.—"SIR,—One of the strata of this neighbourhood, apparently the basis of the Old Red Sandstone, is charged with abundant remains of the Pterygotus, or allied Crustaceans. Unfortunately, when entombed, the remains must have been in a fragmentary state, although they are, or at least their impressions, now beautifully preserved in the stone. I have once met with a nearly complete specimen, about a foot in length, but in every other instance portions only of these creatures have been found—such as the rings of the abdomen, the jaw-feet, and in one instance the prehensile limb. The sculpturing of the rings is often very distinct, but puzzling from its intricacy. I trust this note will be inserted in your valuable magazine, and will catch the eye of some experienced palæontologist, who may kindly tell us if the different species are to be distinguished by their ornamentation, or if this merely varies in the same species according to its period of growth; or, perhaps—for this explanation has also suggested itself—if the different divisions of the body, such as the thorax, segments, and limbs, are likely to be variously sculptured. Far as we are here from all sources of information and comparison with specimens in museums, you will readily understand how valuable some hints on this matter would be.—Yours truly, H. M., Craig, Montrose."

R. A. C. TRING.—The specimen received is *Corbula globosa*, from a septarium of the London Clay.

E. ST. AUBYN.—The fragment of a fossil received, belonged to a large bivalve-shell of the Upper Chalk, the *Inoceramus Cuvieri*. The specimens of this species, from their large size, and comparative thinness of shell, were particularly liable to be broken up; and are everywhere found in the state of fragments, as noticed by our correspondent.

LIVE FROGS.—"SIR,—I observe, in your August number of the GEOLOGIST, the publication of my communication about the Dundonald Frog, and your remarks on the subject. The solution you give is just what I expected, and was prepared for; but even with it I think some other questions arise, which I trouble you with, as they strike me as important. Before however doing so, I may describe, to the best of my ability, the rock, of which I now have a specimen. It is a conglomeratic sandy mass, abounding in fossil remains of vegetable matter, and very hard. The frog, which I think I did not describe previously, is small and attenuated. The head is about double the size of the body, and has a beard attached. The eyes are large, and mouth also considerable. It is unlike any frog I have ever seen; but perhaps its deformity may be accounted for by the fact of its being cooped up in such a confined space, and being denied fresh food and air, as would have allowed it to increase in size, and assume its natural dimensions.

1st. Accepting, then, your assurance that it was a *recent* one,—by which I presume you mean of *existing species*, can any probable guess be made as to its longevity, or how long it has been the tenant of the domicile it was found in?

2d. How long could it have continued to live where it was? I think this question, with the former, bears much upon the subject; because, if it could have existed 100, 50, or even 10 years in such a cavity, what in all the world is there to prevent it doing so for 'myriads of years,' which you consider not only improbable, but almost impossible?

3d. If the frog was at all increasing in size (for I presume that, if it was *generated* in the cavity, it was growing hourly), when it became too large for the cavity, would it have become a part of the stratum, and appeared as a fossil?

4th. The rock is to all appearance quite solid; and, supposing that had a practised and experienced geologist, on examination of the spot where the frog was found, pronounced it free from 'cutters,' or such fissures as could have admitted spawn or air, would such a stratum be sufficiently porous to admit water enough to give the animal such a continuous supply of fresh oxygen, as was necessary for its existence; or did it exist on the oxygen in the cavity alone?

5th. Does not a perpetual change go on in all strata? and, as years roll on, would not the cavity have become virtually hermetically sealed? and, if so, would the frog have continued in life?

6th. Why, when it breathed atmospheric air, did it die at once?

7th. Where and how was the cavity first formed, and was it probably larger at first?

Hoping you will excuse these queries,—Your obedient Servant, R. WARDLAW RAMSEY, Whitehill, 16th November, 1858."

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

GEOLOGICAL SOCIETY OF LONDON, *December 1st*, 1858.—The following communication was read:—

"On the Geological Structure of the North of Scotland and the Orkney and Shetland Islands." Part II. By Sir R. I. Murchison, F.R.S., V.P.G.S.

In a paper read during the last Session (see "Abstracts," No. 10), the author described the general succession of rocks in the Northern Highlands, as observed by Mr. Peach and himself, aided by the researches of some other geologists.

The rocks were described in their ascending order, as first, a fundamental gneiss traversed by granite-veins at Cape Wrath; secondly, a red or chocolate-coloured sandstone and conglomerate, of great thickness, and regarded by the author as of Cambrian age; thirdly, succeeding unconformably, is a series of quartzite, with intercalated limestone, both of them often highly crystalline,—from the limestone Mr. C. Peach had succeeded in obtaining "near Durness," several fossils, shown to be of Lower Silurian age; fourthly, micaceous schists and flagstones occupying a wide extent of country to the east of Loch Eriboll, described as being of younger age than the foregoing, and older than the Old Red Sandstone series which occupies the North-eastern Highlands and a great portion of the eastern coast of Scotland; fifthly, the Old Red series, arranged by the author into three divisions, the middle being the Caithness flags.

In the past autumn Sir Roderick, feeling that several points required stricter examination, revisited the country already described, extending his researches both east and west, and to the most northernly point of the Shetlands.

In this tour he not only confirmed his views previously announced with regard to the succession of the older rocks, but examined the structure of the Orkneys and Shetlands, more clearly defining the relations and physical characters of the beds there composing the Old Red series.

The present memoir comprised the details of these later observations; and Sir Roderick acknowledged the aid he had derived from Mr. Peach (who accompanied him throughout the journey), Mr. John Miller, Rev. Mr. Gordon and others; and he referred to the previous memoirs of Mr. Cunningham and Hugh Miller on Sutherland, &c., and Dr. Hibbert on the Shetland Islands.

The principle points dwelt upon in this paper were—

1. The evidence obtained at various points, that the Lower Silurian limestone is intercalated in quartz-rock (east of Loch Eriboll, Assynt, &c.).

2. That the Durness limestone lies in a basin supported by quartz-rock on the east as well as on the west.

3. That certain igneous rocks connected with the Durness trough are protruded near Smo, which had not before been noticed.

4. On this occasion corroborative evidence was adduced of the conformable superposition of the micaceous schists or gneissose flagstones to the quartzite series, the succession being visible at intervals in all the intermediate country between Loch Eriboll and Ledmore, and the passage upwards from the quartzites and their associated limestones into the schists and micaceous flags being both clear and persistent, with some local interruptions only of igneous rocks.

5. That the protrusion of porphyry, hypersthene, greenstone, &c. is not peculiar to any one line, but occurs in the purple or Cambrian sandstone, in the overlying Silurian limestone of Durness, and again in the still higher micaceous flagstones; and that the latter, when intruded upon by granite, much resemble the old gneiss.

6. With regard to the Old Red series of the east coast, Sir Roderick pointed out the extension of the middle set of deposits, namely, the Caithness flags,—their great thickness in Caithness compared with their development in the south,—and their range over the Orkneys into the Shetlands, where they also thin out, putting on a somewhat different lithological character, and where the Old Red series is chiefly represented by sandstones, the upper part containing plants. He dwelt upon the great value of the Caithness flags as paving-stones, their extraordinary durability being due to a certain admixture of lime and bitumen (the latter derived from fossil fishes) with silica and alumina, whilst in some parts they contain bitumen enough to render them of economic value. The author next pointed out the passage of the Caithness flags upwards into light-coloured sandstones, which eventually form the great headlands of Dunnet and Hoy, where such overlying sandstones cannot be of less thickness than 1,200 to 1,500 feet.

With regard to the micaceous rocks of the north-east of Scotland and the Shetland Isles, they are, according to the author, portions of the series which is younger than the fossiliferous Lower Silurian rocks of the west of Sutherland,—the so-called gneiss of the Sutors of Cromarty belonging, in Sir Roderick's opinion, to the micaceous-flag series of eastern Ross-shire; and the gneissic rock extending southwards to Flowerburn, Kinordy, and Rosemarkie, near Fortrose, is regarded by him as a member of that series, altered by the intrusion of granitic and felspathic rocks.

The paper was illustrated by a large series of rocks and fossils collected during the author's last tour, and by geological maps, and coloured views and sections.

December 15, 1858.—Prof. J. Phillips, President, in the Chair.

The following communications were read:—

1. "On the Succession of Rocks in the Northern Highlands." By John Miller, Esq. Communicated by Sir R. I. Murchison, V.P.G.S.

Mr. Miller in this communication explained the history of our knowledge of the geology of this district; and having given in detail an examination that he made of the coast last autumn, he drew particular attention to the faithful and comprehensive descriptions of the Old Red district by Sedgwick and Murchison in former years, and showed that his own observations quite coincide with the results of Sir Roderick Murchison's late correlation of the Gneissic, Cambrian, Silurian, and Old Red strata of the coasts of Sutherland, Ross-shire, and Caithness.

In conclusion, Mr. Miller pointed out that the Durness Limestone and the Fossiliferous beds of Caithness were still open fields for careful and energetic explorers.

2. "On the Geological Structure of the North of Scotland. Part III. The Sandstones of Morayshire, containing Reptilian Remains shown to belong to the Uppermost Division of the Old Red Sandstone." By Sir Roderick I. Murchison, F.R.S., D.C.L., V.P.G.S., &c.

Referring to his previous memoir for an account of the triple division of the Old Red Sandstone of Caithness and the Orkney Islands, the author showed how the chief member of the group in those tracts diminished in its range southwards into Ross-shire, and how, when traceable through Inverness and Nairn, it was scarcely to be recognised in Morayshire, but reappeared with its characteristic ichthyolites in Banffshire (Dipple, Tynet, and Gamrie).

He then prefaced his description of the ascending order of the strata belonging to this group in Morayshire by a sketch of the successive labours of geologists in that tract; pointing out how in 1828 the sandstones and cornstones of this tract had been shown by Professor Sedgwick and himself to constitute, together with the inferior Red Sandstone and Conglomerate, one natural geological assemblage; that in 1839 the late Dr. Malcomeson made the important additional discovery of fossil fishes, in conjunction with Lady Gordon Cumming, and also read a valuable memoir on the structure of the tract, before the Geological Society, of which, to his, the author's regret, an abstract only had been published. (Proc. Geol. Soc. vol. iii. p. 141.)

Sir Roderick revisited the district in the autumn of 1840, and made sections in the environs of Forres and Elgin. Subsequently, Mr. P. Duff, of Elgin, published a "Sketch of the Geology of Moray," with illustrative plates of fossil fishes, sections, and a geological map by Mr. John Martin; and afterwards Mr. Alexander Robertson threw much light upon the structure of the district, particularly as regarded deposits younger than those under consideration.

All these writers, as well as Sedgwick and himself, had grouped the yellow and whitish-yellow sandstones of Elgin with the Old Red Sandstone; but the discovery in them of the curious small reptile, the *Telerpeton Elginense*, described by Mantell in 1851, from a specimen in Mr. P. Duff's collection, first occasioned doubts to arise respecting the age of the deposit. Still the sections of Capt. Brickenden, who sent that reptile up to London, proved that it had been found in a sandstone which dipped under "Cornstone," and which passed downwards into the Old Red series. Capt. Brickenden also sent to London natural impressions of footprints of an apparently reptilian animal in a slab of a similar sandstone, from the coast-ridge extending from Burgh Head to Lossiemouth (Cummingston).

Although adhering to his original view respecting the age of the sandstones, Sir R. Murchison could not avoid having misgivings and doubts, in common with many geologists, on account of the high grade of reptile to which the *Telerpeton* belonged, and hence he revisited the tract, examining the critical points, in company with his friend the Rev. G. Gordon, to whose zealous labours he owned himself to be greatly indebted.

In looking through the collections in the public museum of Elgin and of Mr. P. Duff, he was much struck with the appearance of several undescribed fossils, apparently belonging to Reptiles, which, by the liberality of their possessors, were, at his request, sent up for inspection to the Museum of Practical Geology. He was also much astonished at the state of preservation of a large bone (*ischium*), apparently belonging to a reptile, found by Mr. Martin in the same sandstone-quarries of Lossiemouth, in which the scales, or scutes, of the *Stagonolepis* (described as belonging to a fish by Agassiz) had been found. On visiting these quarries, Mr. G. Gordon and himself fortunately discovered other bones of the same animal; and these having been compared with the remains in the Elgin collections, have enabled Professor Huxley to decide that, with the exception of the *Telerpeton*, all these casts, scales, and bones belong to the Reptile *Stagonolepis Robertsonii*.

Sir Roderick having visited the quarries in the coast-ridge, from which slabs with impressions of reptilian footmarks had long been obtained, induced Mr. G. Gordon to transmit a variety of these, which are now in the Museum of Practical Geology; and some of which were exhibited at the meeting.

After reviewing the whole succession of strata from the edge of the crystalline rocks in the interior to the bold cliffs on the sea-coast, the author has satisfied himself that the reptile-bearing sandstones must be considered to form the Uppermost portion of the Old Red Sandstone, or Devonian group; the following being among the chief reasons for his adherence to this view.

1st. That these sandstones have everywhere the same strike and dip as the inferior red sandstones containing *Holoptychii* and other Old Red Ichthyolites; there being a perfect conformity between the two rocks, and a gradual passage from the one into the other. 2dly. That the yellow and light colours of the upper band are seen in natural section to occur and alternate with red and green sandstones, marls, and conglomerates low down in the ichthyolitic series. 3dly. That whilst the concretionary limestones called "Cornstones" are seen amidst some of the lowest red and green conglomerates, they reappear in a younger and broader zone at Elgin, and re-occur above the Telerpeton-sandstone of Spynie Hill, and above the Stagonolepis-sandstone of Lossiemouth; thus binding the whole into one natural physical group. 4thly. That, whilst the small patches of so-called "Wealden," or Oolitic strata, described by Mr. Robertson and others as occurring in this district, are wholly uncomformable to, and rest upon, the eroded surfaces of all the rocks under consideration, so it was shown that none of the Oolitic or Liassic rocks of the opposite side of the Moray Frith, or those of Brora, Dunrobin, Ethie, &c., which are charged with Oolitic and Liassic remains, resemble the reptiliferous sandstones and "Cornstones" of Elgin or their repetitions in the coast-ridge extending from Burgh Head to Lossiemouth.

Fully aware of the great difficulty of determining the exact boundary line between the Uppermost Devonian and Lowest Carboniferous strata, and knowing that they pass into each other in many countries, the author stated that no one could dogmatically assert that the reptile-bearing sandstones might not, by future researches, be proved to form the commencement of the younger era.

Sir Roderick concluded by stating, that the conversion of the *Stagonolepis* into a reptile of high organization, but of *nondescript character*, did not interfere with his long-cherished opinion—founded on acknowledged facts—as to the progressive succession of great classes of animals, and that, inasmuch as the earliest Trilobite of the invertebrate Lower Silurian era was as wonderfully organized as any living Crustacean, so it did not unsettle his belief to find that the earliest reptiles yet recognised, the *Stagonolepis* and *Telerpeton*, pertained to a high order of that class.

[The memoir was illustrated by geologically-coloured charts of the Admiralty's Hydrographic Survey of the Coast, extending from the Orkney Islands to Banffshire (which, in the want of any accurate maps, fortunately gives the outlines of the coast and a few miles inland), and by transverse sections showing the succession and relations of the strata, as well as numerous organic remains from the collections of Mr. P. Duff, Mr. Gordon, the Elgin Museum, the Museum of Practical Geology, and the Geological Society's Museum.]

3. "On the *Stagonolepis Robertsonii* of the Elgin Sandstones; and on the Footmarks in the Sandstones of Cummingston." By Thomas H. Huxley, F.R.S., F.G.S., Prof. of Natural History, Government School of Mines.

The unquestionable remains of *Stagonolepis Robertsonii*, which have hitherto been obtained, consist partly of bones and dermal scutes, and partly of the natural casts of such parts. The former have been obtained only at Lossiemouth, and are comparatively few in number; the numerous natural casts, on the other hand, have all been procured at the Findrassie Quarry, in which no bones or scutes in their original condition have been discovered.

The considerable series of remains exhibited to the Society did not embrace all those which had been subjected to examination, but contained only a selection of those more characteristic parts upon which the conclusions of the author of the paper, respecting the structure and affinities of *Stagonolepis*, are based.

They were,—1. Dermal scutes; 2. Vertebræ; 3. Ribs; 4. Bones of the extremities; 5. Bones of the pectoral arch; and 6. A natural cast of a mandible with teeth. The dermal scutes are all characterized by an anterior smooth facet, overlapped by the preceding scute, and by the peculiar sculpture of their outer surface, which exhibits deep, distinct, round, or oval pits, so arranged as to appear to radiate from a common centre. Of these scutes there are two kinds, the flat and angulated. By a careful comparison with the dermal armour of ancient and modern crocodilian reptiles, it was shown that every peculiarity of the scutes of *Stagonolepis* could find its parallel in those of *Crocodilus* or *Teleosaurus;* the flat scutes resembling the ventral armour of the latter; the angulated scutes the dorsal armour of the former genus.

An unexpected verification of the justice of this determination was furnished by a natural cast of a considerable portion of the caudal region of *Stagonolepis*, consisting of no less than seven vertebræ, enclosed within the corresponding series of dermal scutes. Of these, the dorsal set were angulated; the ventral, flat.

It would appear that the anterior dorsal scutes attained a very considerable thickness, while the more posterior scutes were widest—attaining more than five inches in breadth in some instances. The vertebræ described were all studied from natural casts, and belonged to the caudal, sacral, and anterior dorsal series. These vertebræ are, in their leading features, similar to those of Teleosaurians; the obliquity of the articular faces of the centra, so characteristic of the vertebræ of *Stagonolepis*, being, as the author of the paper pointed out, a very common character of Teleosaurian, and even of modern Crocodilian, vertebræ. Of the sacral vertebræ, only a natural cast of the posterior face of the second had been obtained; but it was sufficient to demonstrate the wholly crocodilian characters of this region in *Stagonolepis*.

The dorsal vertebræ present a remarkable peculiarity in the strong upward, outward, and backward inclination of the transverse processes, and in the size of the facet for the head of the rib. The vertebræ thus acquires a Dinosaurian character; but no great weight was attached to this circumstance, as the amount of upward inclination of the transverse processes of the anterior dorsal vertebræ varies greatly in both *Crocodilia* and *Enaliosauria*.

The ribs have well-marked and distinct capitula and tubercula; and the scapula is extremely like that of a crocodile. The femur, though somewhat thick in proportion to its length, and though its articular extremities present such a peculiarly eroded appearance as to lead to the belief that they were covered with thick cartilaginous epiphyses, is also completely crocodilian in its characters.

The natural cast of the mandible is remarkable for the great length and subcylindrical contour of the teeth, the apices of which are slightly recurved. The surface of the tooth is marked by numerous close-set longitudinal grooves, which all terminate at a short distance from the smooth apex. It would appear that the teeth contained large pulp-cavities, and that each was set in a deep and distinct alveolus. Notwithstanding their special peculiarities, these teeth might in many respects be compared with those of the *Teleosauria*.

A metatarsal or metacarpal bone, reproduced from a natural cast, was shown to be similar to that of a crocodile, but so much shorter in proportion to its thickness as to indicate an altogether shorter and broader foot. The cast of an ungual phalanx, on the other hand, proves that *Stagonolepis* had long and taper claws.

Thus far the resemblances with the *Crocodilia* are, on the whole, very close; but the characters of a coracoid obtained from Lossiemouth, separate *Stagonolepis* from all known recent and fossil *Crocodilia*. It is, in fact, a lacertian coracoid, very similar to that of *Hylæosaurus*.

In summing up the evidence thus brought forward as to the affinities of *Stagonolepis*, the author, after comparing it with the oldest known *Reptilia*, expressed his opinion that the peculiar characters of this ancient reptile separate it as widely from the mesozoic *Reptilia* hitherto discovered, as these are separated from the cainozoic members of the same group,—in fact, it widely diverges from all known recent and fossil forms, and throws no clear light on the age of the deposit in which it occurs.

The footsteps from the Cummingston quarries were next described. The largest yet seen by the author are eight or nine inches long, but the majority are much smaller. Prof. Huxley expressed his opinion that all the tracks which he had seen were referable to variously-sized individuals of one and the same species of reptile; and he described at length the only perfect impressions he had observed, the one of a fore-, the other of a hind-foot. The impression of the fore-foot, presented a broad, oval palmar depression, ending in five digits, of which the innermost, representing the thumb, was very broad and short. Each of the outer digits was terminated by a long and tapering claw, and there were clear traces of a web-like membrane uniting these digits as far forwards as the bases of the ungual phalanges. The innermost digit or thumb is directed inwards, as well as forwards, and appears to have been furnished with a thick, short, and much curved nail.

The impression of the hind-foot is smaller than that of the fore-foot, to which, however, it has a general resemblance. It exhibits only four digits, all terminating in taper claws and united by a web. There are indications of a rudimentary outer toe. In one track, where the impression of the fore-foot measured three inches, the stride was twelve inches.

The impressions might very well have been made by such an animal as *Stagonolepis*, with the ungual phalanges of which, indeed, the claw-marks of the footsteps present a close resemblance, while the shortness and breadth of the palmar and plantar impressions harmonize very well with the proportions of the metatarsal or metacarpal bone.

In the course of his remarks, the author took occasion to express his great obligations to Mr. Patrick Duff and the Rev. George Gordon for their zealous and most efficient aid, without which it would have been quite impossible for him to lay so complete a case before the Society.

[This paper was illustrated by original sketches, and by a fine series of tracks from Cummingston and of natural and artificial casts and models of the remains of the *Stagonolepis* (including the specimen originally figured), from the collections of Mr. P. Duff, the Rev. G. Gordon, the Museum of Practical Geology, &c.]

4. "On Fossil Footprints in the Old Red Sandstone, at Cummingston." By S. H. Beckles, Esq. F.G.S.

Mr. Beckles, during a late tour through the Highlands, examined the Sandstone-quarries at Covesea, near Elgin; and having exposed and removed several square yards of the Sandstone-slabs bearing fossil footprints at this place, has sent a large collection of them to London, but has not yet had the opportunity of studying them in detail. Mr. Beccles says that he has secured several varieties of footsteps, differing in size and form, and in the number of the claws, which vary apparently from two to five. One footprint, of a circular shape, measured fifteen inches in breadth. Some of the smaller footprints are evidently formed by young individuals of the same species that made some of the larger marks. Some of the prints have been left, in the author's opinion, by web-footed animals.

Most of the surface-planes of the rock, at different levels, bear footmarks. The majority of the tracks, Mr. Beckles says, are uniserial, the double (or quadrupedal series being exceptional.

Mr. Beckles noticed also impressions of rain-prints well-marked on some of the surface-planes, and indicating the direction of the wind blowing at the time of the rain-fall.

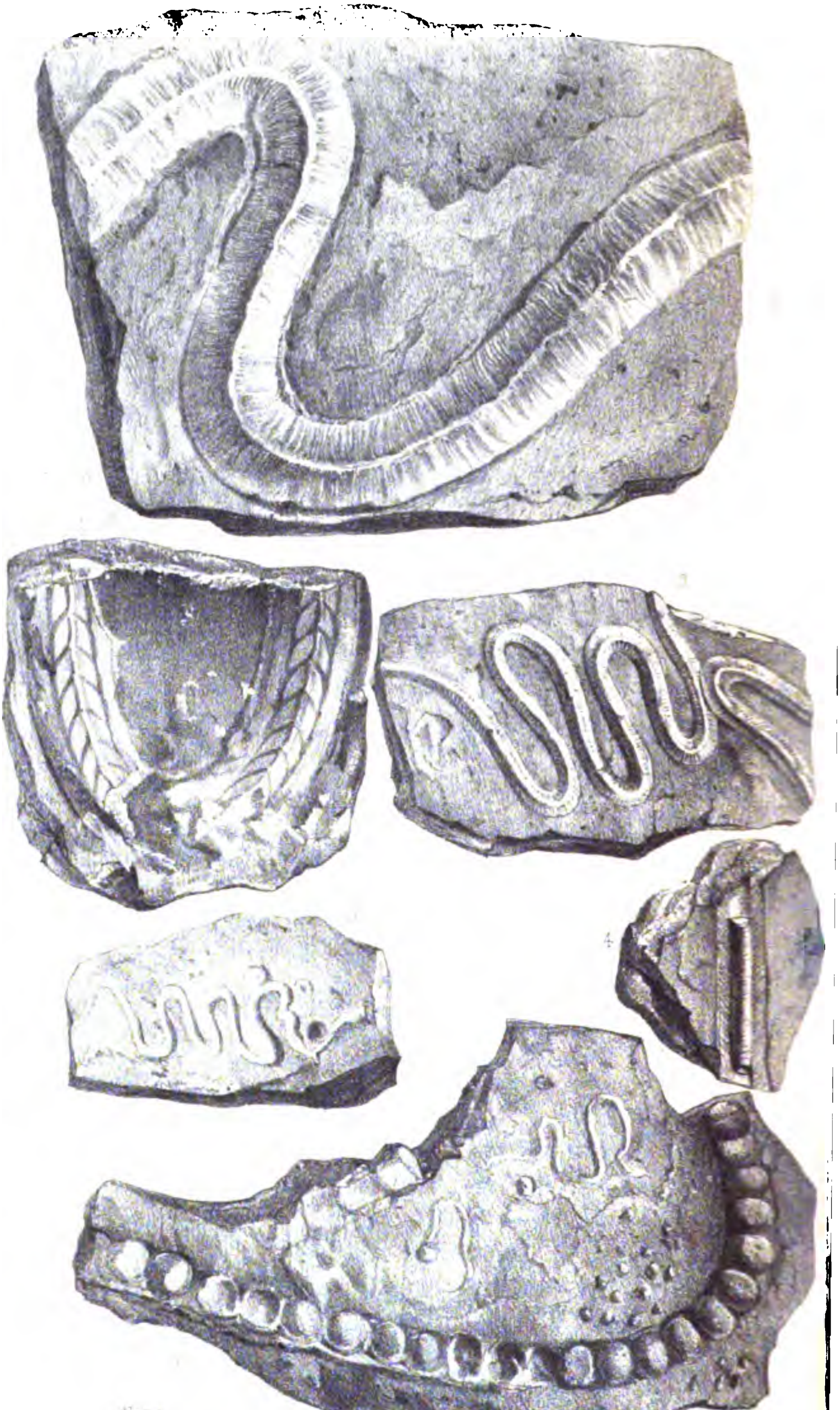
Geologists' Association.—A meeting was held at No. 2, Upper Wellington-street, Strand, on Friday evening, the 17th December, 1858, for the purpose of organizing a new society to promote the study of Geology, and its allied sciences.

The means proposed are the holding of periodical meetings for reading and discussing papers, and the exhibition of specimens, arrangements for facilitating the exchange of specimens between distant members, the formation of a typical collection of fossils suited to the wants of students, the establishment of a library of reference, and the delivery of short courses of lectures.

It was announced, in the course of the proceedings, that 120 applications for membership had been already received.

The first meeting for actual work will take place early in January, when an inaugural address will be delivered by the President, and more detailed plans will be stated.

Vol. II. P.



THE GEOLOGIST.

FEBRUARY, 1859.

ON ROCKS; THEIR CHEMICAL AND MINERAL COMPOSITION, AND PHYSICAL CHARACTERISTICS.

By H. C. Salmon, Esq. Plymouth.

(Continued from Vol. I. page 420.)

2. *On the various chemical and mineral constituents of rocks, and their general relations.*

IX. All rocks are necessarily composed of *minerals*,—that is, of certain "substances which, wherever found, present respectively nearly the same forms and physical characters, and are generally composed of nearly the same chemical constituents." * A rock may consist of one single mineral, in which case it is called a *simple rock;* or it may be made up of an aggregation of several different minerals, when it is called a *mixed rock.* Crystalline limestone, which consists exclusively of one mineral, *calcite*, may be given as a familiar example of a simple rock, and granite, made up of an intimate aggregation of three distinct minerals, *felspar*, *quartz*, and *mica*, of a mixed rock.

Rocks being thus made up of minerals, it will be necessary for us to consider briefly the composition and classification of the latter. They are divided by mineralogists into species, and these species are again grouped together according to various systems of classification.

---

* Phillips's Mineralogy, edited by Brooke and Miller. "A mineral species is a natural inorganic body, possessing a definite chemical composition, and assuming a regular determinate form or series of forms. There are, however, certain limitations with which the above definition must be understood."—Nicol's *Mineralogy.*

The division into species is, in the case of most minerals, natural and obvious; but here, as in the animate kingdoms, the difficulty of drawing distinct lines between species increases as our knowledge extends. Indeed it must be admitted that the line of demarcation between many allied species is often drawn more from empirical and practical considerations than upon any recognisable scientific principle. But if we meet with difficulties in the establishment of species, there is yet greater confusion when we attempt to group these into a systematic classification, and the leading mineralogists differ completely as to the principles upon which it should be carried out. Some insist that they should be grouped solely according to their external forms; some, according to their chemical composition alone; while others prefer an intermediate principle compounded of both. The chemical classification is that adopted in our standard English Mineralogy,* and is the one which we shall follow here, as bearing more nearly upon that higher portion of our subject, the investigation of the chemical genesis of rocks.

X. In dealing with the chemical character of minerals and rocks, I must assume an elementary knowledge of chemistry on the part of my readers. I take for granted that they are aware that all matter, cognisable to us, consists of some one or more of the *sixty-two* elementary bodies, or *elements*, each possessed of certain distinctive physical properties, and combining together according to certain laws; and that these compounds are distinguished by certain names which indicate either their physical properties or their combining proportions. Those who have not this knowledge will find it necessary to acquire it, which can be done from any elementary treatise on chemistry. Mr. Jukes' recently published *Manual of Geology* contains an introductory chapter on chemical mineralogy, by Dr. W. K. Sullivan, to which every student would do well to refer.

These sixty and odd elements are distributed with the widest inequality. One, oxygen, occurs so abundantly as to make up at least *three-fourths* of the terraqueous globe, and some others occur so frequently, and in such large quantities, as to form a notable proportion of the earth's crust; while many again are found so seldom, that their discovery in considerable quantities is of great commercial importance, and some are so rare as to make even small specimens often of considerable value. *Twelve* only, or less than *one-fifth* of the whole, occur frequently, or in abundance, in the rocks at the surface of the earth.

---

* Phillips's, before referred to. Professor Nicol, in his *Manual of Mineralogy*, just quoted, has some important remarks on the classification of minerals. (See chap. iv. p. 99.) He does not adopt the chemical arrangement.

XI. If the elements are distributed with such great inequality, so are minerals likewise. Mineralogists describe about 700 mineral species, but of these comparatively few occur frequently, or still fewer abundantly. On examining rock-formations, we soon find that they are made up, in an enormous proportion, of some few mineral species and varieties, which are met with so abundantly as to justify their being considered as essential parts of the earth's crust, while the great body of mineral species are more or less subordinate. But there is another distinction to be drawn between minerals, besides their greater or less abundance. Some minerals, which occur in comparatively considerable quantities, are almost always found in *veins*, and rarely or never mixed in *rocks* as a constituent ingredient. These we call *vein-forming* minerals; and although some of them occur frequently and abundantly, and are of great geological importance, yet, as they do not form the constituents of rocks, to the consideration of which these papers are exclusively devoted, they do not now come within our scope. In contradistinction to these minerals, which we find only in veins, we term those minerals which we have already referred to as occurring so frequently and abundantly in rocks, *rock-forming* minerals. But besides these rock-forming minerals occurring in great quantity, there are others which, although they are not frequently met with, and are only abundant in some unfrequently occurring rocks, and are sometimes even never abundant, yet form an *essential* though minor constituent of rocks. These we must also class in the category of rock-forming minerals; and we shall consequently notice them here, although they may, on the whole, be far less abundant than many minerals which we exclude, because, existing almost entirely in veins, they do not belong to our present subject.

XII. I have already stated that there are only twelve elements which occur in abundance in rocks—or perhaps I should rather say in the minerals which make up rocks. In considering, however, the chemical nature of the rock-forming minerals, it will be necessary to increase this number to seventeen; the five additional elements, although not occurring abundantly compared with the others, being yet essential and characteristic chemical constituents of many rock-forming minerals. The following is a list of these seventeen elements with their chemical symbols affixed :—

1. Oxygen	O.	6. Fluorine	Fl.	11. Magnesium	Mg.
2. Hydrogen	H.	7. Silicon	Si.	12. Barium	Ba.
3. Carbon	C.	8. Boron	B.	13. Potassium	K.
4. Sulphur	S.	9. Aluminium	Al.	14. Sodium	Na.
5. Chlorine	Cl.	10. Calcium	Ca.	15. Lithium	Li.
16. Iron	Fe.	17. Manganese	Mn.		

XIII. These seventeen elements, combined in the most various proportions, make up the entire mass of rocks, excepting some rare and exceptionable species,—and also excepting, of course, their containing veins. As fifteen of them, however, always occur in rocks in certain definite binary combinations,—for instance, oxygen combines with fourteen of them to form the most abundant rock constituents,—it will simplify our view of the general chemical nature of rocks and their minerals, if we regard these important binary compounds directly. I have therefore compiled the following table of twenty-one substances (two *elements*, and nineteen *binary compounds*) which entirely make up the constituents of rocks, either as minerals themselves, or as forming the chemical components of minerals. To the ordinary chemical symbols, I have appended the abbreviated symbols generally used by mineralogists, and which will be adopted for the future in these papers. In this mode of notation, the double atom of any element is indicated by a *line* drawn through the sign of a single atom; the atoms of oxygen are marked by *dots* over the sign of the other elements, and those of sulphur similarly by *accents*.

LIST OF ELEMENTS AND BINARY COMPOUNDS, EITHER BEING THEMSELVES ROCK-FORMING MINERALS, OR FORMING CONSTITUENTS OF ROCK-FORMING MINERALS.

Those marked with an asterisk (*) are *minerals*,—that is, occur naturally; those with a double asterisk (**), abundantly. The others form the chemical constituents of minerals, but are not minerals themselves.

			Chemical Symbol.	Abbreviated Mineralogical Symbol.
ELEMENTS.	1. **Carbon		C	C
	2. *Sulphur		S	S
BINARY COMPOUNDS.	3. **Water		HO	$\dot{\mathrm{H}}$
	4. *Alumina	Earths.	Al^2O^3	$\dddot{\mathrm{Al}}$
	5. Lime		CaO	$\dot{\mathrm{Ca}}$
	6. *Magnesia		MgO	$\dot{\mathrm{Mg}}$
	7. Baryta		BaO	$\dot{\mathrm{Ba}}$
	8. Potash	Alcalies.	KO	$\dot{\mathrm{K}}$
	9. Soda		NaO	$\dot{\mathrm{Na}}$
	10. Lithia		LiO	$\dot{\mathrm{Li}}$
	11. **Silicic Acid	Acids.	SiO^2	$\ddot{\mathrm{Si}}$
	12. Carbonic Acid		CO^2	$\ddot{\mathrm{C}}$
	13. Sulphuric Acid . . .		SO^3	$\dddot{\mathrm{S}}$
	14. *Boracic Acid		BO^3	$\dddot{\mathrm{B}}$
	15. **Sesqui-oxide Iron . .	Oxides.	Fe^2O^3	$\dddot{\mathrm{Fe}}$
	16. Protoxide Iron		FeO	$\dot{\mathrm{Fe}}$
	17. *Sesqui-oxide Manganese		Mn^2O^3	$\dddot{\mathrm{Mn}}$
	18. Protoxide Manganese. .		MnO	$\dot{\mathrm{Mn}}$
	19. **Chloride Sodium . .	Chloride, Fluoride, and Sulphide.	NaCl	NaCl
	20. *Fluoride Calcium . .		CaFl	CaFl
	21. *Bi-Sulphide Iron . .		FeS^2	$\overset{\prime\prime}{\mathrm{Fe}}$.

Carbonic and Sulphuric acids also occur naturally in volcanic regions, in the form of gases. Lime, Magnesia, and Baryta are also called Alcaline Earths.

XIV. Of the elementary bodies it therefore appears that only two —*carbon* and *sulphur*—are found as minerals in any considerable quantity. In composition they are unimportant in rocks, except in the binary compounds given.

Of the binary compounds also there are proportionately few which, directly as minerals, have an important share in the formation of the earth's crust; the greater quantity occur in rock-forming minerals, in chemical combination with each other, forming compounds of a higher order. Those binary compounds which are met with in quantity as minerals, are *water*, *silicic acid* as silica, *sesqui-oxide of iron* as hematite, and *chloride of sodium* as rock-salt. Those substances will be referred to more fully hereafter, in considering them as minerals. We also find *alumina*, *magnesia*, *boracic acid*, *sesqui-oxide of manganese*, *fluoride of calcium*, and *bi-sulphide of iron*, as the minerals corundum, periclase, sassoline, braunite, fluor, and pyrite. The first occurs in a small rock-formation, as emery; the three following are rare and unimportant; but the two latter are rock-forming minerals, though not very abundant.

It remains for us now to consider the combinations of these binary compounds among themselves. *Water* plays an important part in combination, forming an essential and considerable constituent of many rock-forming minerals, as gypsum, chlorite, and serpentine. The first three earths, *alumina*, *lime*, and *magnesia*, in combination with *silicic*, *carbonic*, and *sulphuric acids*, form an important portion of the earth's crust: the combinations of *baryta* with the acids are comparatively trifling. The first two alcalies—*potash* and *soda*—also occur abundantly in wide-spread minerals; *lithia* is much rarer.

The first three acids are also of the greatest importance; particularly *silicic acid*, which, in a free state, as quartz, or in chemical combination with the earths and alcalies, it is estimated, alone constitutes forty-five per cent. of the earth's mineral crust. *Carbonic acid*, although far inferior to the last-named acid, also enters as a main constituent of wide-spread mountain-masses. *Sulphuric acid* is also an important rock-constituent: *boracic acid* is unimportant as to quantity.

The *oxides* of *iron* and *manganese*—the protoxides of which only exist in combination—form an essential constituent of many wide-spread rock-forming minerals. *Chloride of sodium*, *fluoride of calcium*, and *bi-sulphide of iron*, are not regarded as entering into combinations.

XV. The general conclusions we arrive at regarding the chemistry of the rock-forming minerals is this: with the exception of the nine following minerals, which are either elements or binary compounds, viz.—

(1.) *Carbon,*
(2.) *Sulphur,*
(3.) *Water,*
(4.) *Corundum* (Alumina),
(5.) *Silica Quartz* (Silicic Acid),
(6.) *Hematite* (Sesqui-Oxide or Per-Oxide of Iron),
(7.) *Rock Salt* (Chloride of Sodium),
(8.) *Fluor* (Fluoride of Calcium),
(9.) *Pyrite* (Bi-Sulphide of Iron),

all the other rock-forming minerals are essentially either—

I. Silicates,
II. Carbonates,
III. Sulphates, or
IV. Borates ;

that is, combinations of *silicic acid*, *carbonic acid*, *sulphuric acid*, or *boracic acid*, with the earths, alcalies, and oxides given in the table in XIII. Of these, as already stated, the silicates are by far the most abundant; the carbonates come next; then the sulphates: the borates are insignificant. In examining in detail into the minerals formed by each of these acids, it will be convenient to reverse the order given above, and first dispose of the least important. We shall, consequently, take them in the following order:—borates, sulphates, carbonates, silicates.

XVI. Borates, Sulphates, Carbonates.—The only essential *borate* which we find as a rock-forming mineral—and it only rarely—is *Boracite* ($\dot{Mg}^3\,\dddot{B}^4$), a borate of magnesia. But boracic acid also occurs as an essential constituent of the important mineral *Tourmaline*, averaging about 9 per cent.

The only *sulphates* forming rock-minerals are those of Lime and Baryta. *Anhydrite* ($\dot{Ca}\,\dddot{S}$) and *Gypsum* ($\dot{Ca}\,\dddot{S} + \dot{H}^2$) are respectively an anhydrous, and a hydrous sulphate of lime. *Gypsum* is a most abundant rock, occurring in many sedimentary formations. *Baryte* ($\dot{Ba}\,\dddot{S}$), or heavy-spar, is a sulphate of Baryta; it is a rare ingredient in rocks, and indeed is more a vein-forming than a rock-forming mineral.

The rock-forming *carbonates* are those of Lime, Magnesia, and Iron. The first, in the form of *Calcite* ($\dot{Ca}\,\ddot{C}$), carbonate of lime, is the base of all limestones and chalks, and is the most abundant of any mineral not being a silicate. *Magnesite* ($\dot{Mg}\,\ddot{C}$), a carbonate of magnesia, is neither an abundant nor important mineral in its pure state; but in combination with carbonate of lime, it forms the mineral *Dolomite* ($\dot{Ca}\,\ddot{C}$, $\dot{Mg}\,\ddot{C}$), or bitter-spar, which is the base of the large formation of magnesian limestone. Carbonate of iron, *Chalybite* ($\dot{Fe}\,\dot{C}$), is not an abundant rock-mineral, although it is a considerable ingredient in some rock formations.

Summing up these minerals, and arranging them in their order of importance, we find that all the carbonates, sulphates, and borates only produce the eight following rock-forming minerals; and even of these, five are unimportant in quantity:—

(1.) *Calcite* (Carbonate of Lime).
(2.) *Magnesite* (Carbonate of Magnesia).
(3.) *Chalybite* (Carbonate of Iron).
(4.) *Dolomite* (Carbonate of Lime and Magnesia).
(5.) *Anhydrite* (Sulphate of Lime).
(6.) *Gypsum* (Hydrated Sulphate of Lime).
(7.) *Baryte* (Sulphate of Baryta).
(8.) *Boracite* (Borate of Magnesia).

Hence, with the exception of these eight minerals, and the nine minerals already enumerated, formed of elements and binary compounds, in all 17, *the whole of the other rock-forming minerals are silicates.*

XVII. SILICATES.—The principal constituents of all rocks, with the exception of Limestones, Magnesian Limestones, and Gypsums, are silicated minerals. Indeed, the crystalline rocks, and many sedimentary strata which constitute by far the greater part of the known surface of the earth, consist chiefly of silicates; and therefore a knowledge of their chemical character becomes of the greatest importance.*

Silicates may be either *simple* silicates, or *compound* silicates. A simple silicate is a combination of the acid with one single base, uncombined with any other; a compound silicate is a compound between the acid and two or more bases combined.

XVIII. *Simple Silicates.*—The simple silicates are of much less geological importance than the compound, as they occur much less frequently. Of the earths, we have simple silicates of Alumina, Lime, and Magnesia, but not of Baryta. The anhydrous silicates of Alumina, such as *Andalusite* and *Kyanite* ($\dddot{\bar{\mathrm{A}}}\mathrm{l}\ \dddot{\mathrm{Si}}$), are by no means abundant minerals; indeed they are less so than the simple hydrous silicates, such as *Kaolin* ($\dddot{\bar{\mathrm{A}}}\mathrm{l}\ \dddot{\mathrm{Si}} + \dot{\mathrm{H}}^2$), which are more important, inasmuch as they form the base of all clays which have resulted from the decomposition of ancient felspathic rocks. The simple silicates of lime, such as *Wollastonite* ($\dot{\mathrm{Ca}}\,\ddot{\mathrm{Si}}$), are likewise unimportant. Of the simple silicates, those of Magnesia, such as *Steatite* ($\dot{\mathrm{Mg}}\,\ddot{\mathrm{Si}}$) and *Talc*, are the only ones which occur in abundance, and form important constituents of large rock-masses. Silicates of the alcalies do not occur uncombined as minerals, although combined with the earthy bases they constitute a large part of the most frequently occurring silicated minerals: this arises from their great solubility. Simple silicates of the oxides of iron and manganese are, however, met with, although not in any abundance. Persilicate of iron has a light ochre colour, but the protosilicate is green. The mineral *Glauconite*, or green-earth, is essentially a silicate of protoxide of iron; granules of it are frequently abundant in chalk, tertiary, and other strata. Simple silicates of manganese also occur, but in trifling quantities; most of them are hydrated.

---

* Bischof, ii. 82.

XIX. *Compound Silicates.*—The vast mass of minerals are made up of compound silicates. Among the bases which are found most frequently and abundantly in this class of minerals, Alumina is by far the most important. In a large number of them—and these among the most important—it is the prevalent base, and of the whole number of compound silicates there are comparatively few in which it is wholly absent. Next to Alumina, the alcaline earths, Lime and Magnesia, and the alcalies, Potash and Soda, are the most abundant bases in this class of silicates. Lithia is comparatively rare, and Baryta occurs in such trifling proportions as not to be worth our consideration here. The silicates of Iron and Manganese are also important constituents of compound silicates; they are usually the protoxides of these metals. The compound silicates are consequently made up of various combinations of the silicates of

1. Alumina.
2. Lime.
3. Magnesia.
4. Potash.
5. Soda.
6. Lithia.
7. Proto (per) Oxide Iron.
8. Proto (per) Oxide Manganese.

XX. The following synopsis of the most important simple and compound silicated minerals will give a general idea of the chemical relations of this important and complicated class of rock-constituents:—

SIMPLE SILICATES OF

ALUMINA	1. *Andalusite* or *Chiastolite*.
	2. *Kyanite*.
	3. *Kaolin*. Hydrated.
LIME	4. *Wollastonite*.
	5. *Datolite* and *Apophyllite*. Zeolites.
MAGNESIA	6. *Talc*. Generally some $\dot{\mathrm{Fe}}$.
	7. *Steatite*. ditto.
	8. *Serpentine*. Hydrated. $\dot{\mathrm{Mg}}$ often largely replaced by $\dot{\mathrm{Fe}}$.

COMPOUND SILICATES OF

ALUMINA AND LIME	9. *Wernerite*, or *Scapolite*. Part of $\dot{\mathrm{Ca}}$ generally replaced by $\dot{\mathrm{Na}}$, $\dot{\mathrm{K}}$.
	10. *Anorthite*. Felspar species; part of $\dot{\mathrm{Ca}}$ generally replaced by $\dot{\mathrm{Mg}}$, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$.
	11. *Stilbite* or *Desmine*, *Heulandite*, *Leonhardite*, *Scolezite* or *calcareous Mesotype*, *Chabasite* (often with $\dot{\mathrm{Na}}$), *Laumonite*, *Prehnite* (often with $\dot{\mathrm{Fe}}$). All zeolites.
ALUMINA AND MAGNESIA . .	12. *Soapstone*. Hydrated; generally with $\dot{\mathrm{Fe}}$.
ALUMINA AND POTASH . . .	13. *Orthoclase*. Common, or Potash Felspar.
	14. *Leucite*. A Felspar species.
	15. *Harmotome* or *Baryta-Harmotome*, with silicate of $\dot{\mathrm{Ba}}$. A zeolite.
ALUMINA AND SODA	16. *Albite*. Soda Felspar, a small portion of $\dot{\mathrm{Na}}$ usually replaced by $\dot{\mathrm{Ca}}$, $\dot{\mathrm{K}}$.
	17. *Sodalite*. Combined with Na Cl (Chloride of Sodium).
	18. *Mesotype* or *Natrolite*, and *Analcime*. Zeolites.
ALUMINA AND LITHIA . . .	19. *Petalite*. Lithia Felspar; often contains $\dot{\mathrm{Na}}$.
	20. *Spodumene*, or *Triphane*. A Felspar species; often with $\dot{\mathrm{Na}}$.
ALUMINA AND PER-OXIDE IRON	21. *Staurolite*.
	22. *Bole*. Hydrated; allied to Kaolin, and the bases of clays.
ALUMINA, LIME, AND SODA. .	23. *Oligoclase*. A Felspar species.
	24. *Labradorite*. ditto.
	25. *Andesine*. ditto.
	26. *Epistilbite*, *Mesolite*, *Thomsonite*, and *Comptonite*. Zeolites.
ALUMINA, SODA, AND POTASH .	27. *Sanidine* or *Adularia*. Glassy Felspar.
	28. *Ryacolite*. A Felspar species.
	29. *Nepheline*. ditto.
ALUMINA, LIME, AND IRON . .	30. *Epidote*.
ALUMINA, LIME, MAGNESIA, AND IRON	31. *Garnet*. The mineral is very variable in its composition, and has many varieties. The proportions of $\dddot{\mathrm{Al}}$, $\dot{\mathrm{Ca}}$, and the two oxides of iron vary greatly. It often contains Mn.
	32. *Idocrase* or *Vesuvian*.
ALUMINA, MAGNESIA, & IRON .	33. *Cordierite*.

Alumina, Magnesia, & Iron	34. *Ripidolite.*
	35. *Chlorite.*
Alumina, Magnesia, Iron, and Potash	36. *Biotite* or *Magnesia-Mica.*
	37. *Pinite.* Altered Cordierite, some $\dot{Mg}$ replaced by $\dot{K}$.
	38. *Tourmaline.* A mineral of various and complicated chemical constitution. Contains $\dot{Na}$ with $\dot{K}$, also about 9 per cent. of Boracic acid, and 3 per cent. of Fluorine.
Alumina, Iron, and Potash	39. *Potash-Mica.* Has sometimes Mn.
Alumina, Iron, Potash, Lithia, and Manganese	40. *Lepidolite,* or *Lithia-Mica.* Also Hydrofluoric acid.
Magnesia, Lime, and Protoxide Iron	41. *Hornblende.* Often some $\dddot{Al}$.
	42. *Augite.* ditto.
	43. *Diallage.* Generally some $\dddot{Al}$, also $\dot{H}$ and $\dot{Mn}$.
	44. *Hypersthene.* Generally $\dddot{Al}$ and $\dot{Mn}$.
Magnesia and Iron	45. *Olivine.*
	46. *Bronzite.* Some $\dot{H}$.

THE GEOLOGY OF BEADNELL, IN THE COUNTY OF NORTHUMBERLAND, WITH A DESCRIPTION OF SOME ANNELIDS OF THE CARBONIFEROUS FORMATION.

By George Tate, Esq. F.G.S.

Read before the Berwickshire Naturalists' Club, at Beadnell, in May, 1858.

A section along the coast from Ebbs Nook to Annstead Bay, of nearly one and a half miles in length, exhibits a fine series of rocks belonging to the Mountain Limestone Formation. Thick sandstones and limestones, shales with ironstone, and coal-seams are intercalated with each other; and these strata are traversed by a lead-vein and a basaltic dyke. As we wander along the shore, we meet with evidences of sea-deposits in the limestones and calcareous shales, wherein are embedded many corals and mollusks; the sandstones, shales, and coal afford relics of the vegetation of the Carboniferous Era; some slaty sandstones give distinct indications of ancient shallow seas and coast-lines, whereon the waves broke gently and over which worms crawled; while the basaltic dyke tells of the play of internal forces, rending asunder the vast mass of stratified rocks, and pouring molten lava into the fissures.

The general dip of the strata, about 15°, is south-east, and as we proceed northward we pass over the lower beds in succession. There are a few dislocations and faults, and in some parts the limestones are thrown into wave-like ridges and hollows; but the contortions are not so remarkable as at Howick, Holy Island, and Scremerston. As the greater proportion of the middle group of the mountain-limestone rocks is seen here, the following section will be instructive, giving, as it does, the strata in detail from the highest at Ebbs Nook, down to the lowest which have been reached by pit-sinkings in the neighbourhood. It has been made out by repeated examinations of the coast, collated with information derived from pit-sinkings, which has been kindly supplied to me by my friend, Mr. William Wilson, the intelligent manager of the Shilbottle Colliery. The lower strata from No. 68 downward are taken entirely from pit-sections.

SECTION.

		ft.	in.
1.	Ebbs Nook Magnesian limestone, containing *Productus giganteus*, *Spirifer lineatus*, *Chætetes septosus*, *Lithostrotion basaltiforme*, *Syringopora ramulosa*, *&c.*	30	0
2.	Red, flaggy sandstone, ripple-marked	4	0
3.	Shale, reddish at top, darker and carbonaceous in lower beds	20	0
4.	Coal	1	2
5.	Fire-clay and shale . . .	7	0
6.	Flaggy sandstones, micaceous along the laminæ; with borings of annelids! . . .	30	0
7.	Shale	5	0
8.	Sandstones with ripple-marks, false-bedding, and worm-casts and trails . .	40	0
9.	Shales	27	0
10.	Limestones, generally blue; some beds dun, weathering buff; a calcareous shale, 2 ft. 6 in. is interstratified: —*Productus giganteus*, *Aulophyllum fungites*, *&c.* .	28	0
11.	Coal mixed with shale . .	0	6
12.	Arenaceous shale	1	0
13.	Sandstones, some blotched and red, others flaggy; *Stigmaria ficoides* in upper beds, annelids in flaggy beds	24	0
14.	Shale with ironstone-nodules	15	0
15.	Limestone, generally blue: —the basaltic dyke cuts through these beds near the shore	18	0
16.	Coal	0	6
17.	Grey shales with ironstone-nodules	10	0
18.	Blue shales	15	0
19.	Grey slaty sandstone . . .	5	0
20.	Coal (*stony coal*)—this is very nearly in the same position in the series as the fine "Shilbottle-seam" . . .	1	0
21.	Slaty sandstones	8	0
22.	Blue slates	7	0
23.	Slaty sandstones and shales —some beds are ripple-marked, and the vein of Galena is seen crossing the sandstone	37	0
24.	Shales	10	0
25.	Limestone, dark	6	0
26.	Grey slaty sandstones and shales	27	0
27.	Calcareous shale; with many fossils	3	0
28.	Limestones much contorted; the upper beds impure, but the middle and lower make good lime. These beds were		

	worked here until lately; and also at North Sunderland, where they are brought in through the undulations and faults of the strata. They are very fossiliferous.	24	0
29.	Coal	0	8
30.	Fire-clay and shales	10	0
31.	Sandstone, upper beds slaty.	30	0
32.	Carbonaceous shales with ironstone-nodules	10	0
33.	Limestone, dun and impure —*Productus giganteus*	4	0
34.	Carbonaceous shales	12	0
35.	Coal ("Beadnell-coal"). Varies in thickness from 2 ft. 6 in. to 6 ft.; the average about	3	0
36.	Sandstones and slaty sandstones with *Sigillaria organum*	17	0
37.	Coal	1	5
38.	Grey slaty and flaggy sandstones	45	0
39.	Shales	8	0
40.	Grey slaty sandstone	6	0
41.	Shales	10	0
42.	Sandstones, some of the beds red	38	0
43.	Grey shales	22	0
44.	Limestone	2	6
45.	Grey slaty sandstones	6	0
46.	Fire-clay and shales	30	0
47.	Coal (*stone-close-coal*)	1	4
48.	Grey slaty sandstone	10	0
49.	Dark shale	5	0
50.	Slaty sandstone	10	0
51.	Dark shale	18	0
52.	Limestone	14	0
53.	Coal	0	4
54.	Grey sandstones and slaty sandstones	9	0
55.	Limestone	5	0
56.	Coal ("Swinhoe coal")	1	4
57.	Sandstones	27	0
58.	Grey shale	9	0
59.	White sandstone	12	0
60.	Blue shale	36	0
61.	Limestone, impure	6	0
62.	Coal	0	9
63.	Fire-clay and shales	24	0
64.	Coal ("Fleetham coal," of good quality)	1	6
65.	Sandstones	132	0
66.	Blue shales	33	0
67.	Sandstone	21	0
68.	Limestone	21	0
69.	Coal	0	4
70.	Slaty sandstones and shales.	60	0
71.	Coal	0	10
72.	Fire-clay	48	0
73.	Limestone, light-coloured	6	0
74.	Coal, mixed with sandstone.	2	0
75.	Shales and slaty sandstone	15	0
76.	Limestone, impure	2	0
77.	Coal	2	0
78.	Sandstones	150	0
79.	Slaty sandstone	30	0
80.	Blue shale	6	0
81.	Hard stone	4	0
82.	Sandstone, coarse, white.	15	0
83.	Blue shale	12	0
84.	Coal, good	1	8
85.	Slaty sandstones	27	0
86.	Coal ("main coal")	4	0
87.	Fire-clay	5	0
88.	Blue shale	42	0
89.	Limestone	4	0
	Total	1,493	10

There are in this section fourteen different limestones, varying in thickness from 2 to 30 feet, and having an aggregate thickness of 171 feet. Most of them are of a bluish colour and yield good lime; many fossils characteristic of the mountain-limestone formation occur, especially in the thicker sills and in the calcareous shales connected with them. The main limestone, No. 28, is the most fossiliferous; and the following list, though far from complete, will show how rich it is in organic remains:—

FISH.

A few remains of fish appear, viz.—
Megalichthys Hibberti, Ag. (scales, of a quadrate form, one inch across.)
Cladodus mirabilis, Ag. (teeth).
Cochliodus magnus, Ag. (teeth).

CRUSTACEA.

Griffithides Farnensis, Tate.

s *giganteus* and other commoner mountain-limestone fossils, it with large masses of the corals *Lithostrotion basaltiforme* and *septosus;* and occasionally we find *Syringopora ramulosa,* a rare coral in the Northumberland beds. These distinctive ns are excellent guides in tracing the range of this "sill." ard I have found it at Holy Island, and southward I have t to Spittleford, near Embleton, and to Dunstan, Craster, and tle; thence in a south-west direction to Whittle, Newton-on- or, Framlington, and across the Coquet to Ward's Hill and r. It should be noticed that the magnesian character of this ne is a local phenomenon, seemingly in some way arising from ximity of basalt; in several parts of its range, as at Shilbottle amlington, it is a comparatively pure carbonate of lime.

re are eighteen different coal-seams in the section; most of them d of an inferior quality; only two exceeding 2 feet in thick- their aggregate thickness being only 24 feet 4 inches. That is called the "Beadnell-coal" (No. 35) has been worked both mestic use and for lime-burning. It is of variable thickness, n less than 2 feet 6 inches, and generally about 3 feet; but on Taylor's estate it has been found as much as 6 feet thick, and of ter quality than in other localities. It lies there, however, below ea-level; and as the sea some time ago broke into a neighbouring ry, due precautions would be necessary to prevent a similar tion, in the event of this more valuable portion being worked for use of the district.

he sandstones and shales associated with the coal-seams contain s of the vegetation of the Carboniferous Era; *Stigmaria ficoides* ear abundantly in these beds, with a few Sigillariæ. One interesting cimen of Sigillaria, laid bare in quarrying the sandstone in 1853, rves a more particular notice; although but a fragment, it was feet in height, two feet two inches in diameter at the lower end, one foot nine inches at the higher. It stood perpendicular to the nts, which dip 15° south-east, and its inclination to the horizon was The lower extremity terminated abruptly on the surface of slaty [illegible] the outcrop of the rock in which it was embedded [illegible] ing how far upward it extended. Over its surface [illegible] coating, [illegible] he bark converted into coal;

but the interior was replaced with sandstone, retaining no structure, but bearing, however, the rude flutings which distinguish the casts of Sigillariæ: it appeared to belong to the species *Sigillaria organum*. The sandstone in which it stood consists of several beds; the lines of stratification distinctly passing through the fossil, and curving more or less downward on all sides towards it. No roots could be observed attached to this tree; yet from its position at right angles to the strata, and the peculiarity of the stratification, I think it originally grew on the spot. Indeed, there seems to me little doubt that most of the coal-seams, even in northern Northumberland, have been formed of plants and trees which grew, during the Carboniferous Era, in the district now occupied by the coal-beds; the under-clay usually beneath each coal-seam having been the surface-soil on which they grew, it is now found more or less traversed by the *Stigmaria ficoides*,—the roots of Sigillariæ,—the trunks of which have largely contributed to the formation of the coal. As this fossil tree is frequently to be seen in Northumberland, it may add to the interest of these notes to give the following description from my "Fossil Flora of the Eastern Borders." "The structure of the Sigillariæ differs widely from that of any living plant; it is, however, essentially acrogenous; and the nearest analogue to those majestic trees of other times is the Lycopod or lowly-creeping club-moss; yet the radial arrangement of the woody tissue and the presence of medullary rays and a sheath bring them into a distant relationship to exogenous vegetation. Brongniart considers them allied both to the Lycopod and to the Cycas; they form, therefore, a connecting link between orders which stand far apart in existing nature. Composed chiefly of cellular tissue, the Sigillariæ were extremely succulent; they grew in swamps and marshes, their long and numerous roots and rootlets (Stigmaria) forming an entangled mass and permeating the mud in all directions, in a manner similar to that of the living water-lily in shallow lakes and pools. The roots sometimes exhibited a crucial arrangement, uniting into four main portions, separated from each other by deep channels and forming a dome, from the summit of which the furrowed and scarred stems, clothed in the upper parts with a long, narrow, and pendent foliage, rose to the height of nearly 100 feet." *

---

* Tate's "Fossil Flora of the Mountain Limestone Formation," in Dr. Johnston's "Botany of the Eastern Borders," p. 299.

Other conditions of the Carboniferous Era are made known by several of the sandstones, which present ripple-marks, oblique lamination, and fossil worms and worm-tracks, indicating ancient beaches and the action of waves and currents. When deposits are made in comparatively tranquil water, the planes of the several beds are pretty nearly parallel to each other; but some sandstones exhibiting in mass this ordinary stratification have also included in them thin layers or stratula, which are inclined sometimes highly to the plane of the principal bed; of this oblique lamination, or, as it is frequently called, *false-bedding*, there are many examples in the "Beadnell-sandstones." Both ripple-marks and false-bedding result from the action of waves and currents; the former being produced by the gentle motion of waves, and the latter by stronger currents. After the recession of the tide, furrows and ridges may be seen on sandy and muddy coasts; these are similar in form and arrangement to those left impressed by ancient waves on the "Beadnell-sandstones," in which they are beautifully distinct; some of them are large, measuring six inches from one ridge to the other, and they usually trend from east by south to west by north. As the line in which a current moves is at right angles to the direction of such marks, the ancient currents which rolled over the Beadnell coast must have come either from the north or the south.

Mr. H. C. Sorby has attempted to determine the direction whence currents came by observations on the dip of the stratula, as he considers the direction to be the opposite to this dip in relation to the plane of true bedding; and he concludes from a series of observations, that the drifting current which formed the carboniferous sandstone-beds of the southern part of the coast of Northumberland came from north 9° east.* The "Beadnell-beds," however, do not not lead to any such general conclusion, for I found in the same stratum, and within a distance of not many yards, that the stratula in one place dipped from 40° to 70° to the north, and in another place at similar angles to the south-west by south. Probably this bed had been formed by the action of strong eddies and counter currents, which piled up the drifted sand with considerable irregularity.

Most curious and instructive are the fossil worms and their tracks which occur in several layers of flaggy and ripple-marked sandstones

---

* Proceedings of the Yorkshire Geological Society for 1852, p. 232.

a little northward of Ebbs Nook. They are seen also in other sandstone beds of the section, as well as in other localities in Northumberland. Though similar annelids are not unfrequent in Palæozoic rocks, they have been but seldom noticed. Species from the Silurian rocks have been described by Sir R. Murchison in his great work the "Silurian System," by Professor McCoy in Sedgwick's "Synopsis of the Classification of British Palæozoic Rocks," and by Mr. J. W. Salter in the Quarterly Journal of the Geological Society. Few distinct descriptions have been given of such forms in the Carboniferous formation; the only notices I know of are contained in a paper by Mr. E. W. Binney, "On some Trails and Holes formed in rocks of the Carboniferous Strata;" * and in an excellent popular "Account of a large fossil, marine worm, occurring in the Mountain-limestone district in Wensleydale, Yorkshire," by Mr. Edw. Wood, F.G.S.† Mr. W. Lee also refers to annelid-borings, in a paper on what he calls "Fossil Footprints in the Carboniferous system." ‡ Having carefully examined the annelids in the Mountain-limestone formation of Northumberland, I am able to distinguish four distinct forms; two of them are referable to *Crassopodia* (McCoy), a genus which has been found in Silurian beds, and which may be thus defined :—Body long; formed of excessively short, numerous, wide segments, from which arise very long, delicate, crowded cirri forming a broad dense fringe on each side, completely concealing the feet. These annelids appear to belong to the order Dorsibranchiata of Cuvier, and are allied to the nereides which now inhabit our coast. These latter are marine worms which creep in a serpentine manner, and even swim by successive undulations of their bodies or by agitating their appendages.

CRASSOPODIA EMBLETONIA § (Tate). Plate II. figs. 1, 2.

Length unknown (upwards of two feet); width one inch; thickness not exceeding four lines; width of body five lines; articulations three lines apart; cirri about four lines long, crowded, there being twenty-four in the space of one inch. There is no appearance of a head; the width and characters are the same throughout the entire length; it occurs in large rounded loops from half an inch to more than three inches apart.

---

* Memoirs of the Manchester Philosophical Society, vol. x. p. 181.

† The Naturalist, Nos. I. and II. pp. 14 and 41.

‡ Proceedings of the Yorkshire Geological Society, vol. ix. p. 409.

§ I have named this after my esteemed friend, Mr. R. C. Embleton, the accomplished Secretary of our Club.

Having found sections showing the interior of this curious fossil, I have been able to determine the width of the body, and the distance of the articulations from each other.

This is the most widely distributed of the carboniferous annelids; it occurs in sandstones of the mountain-limestone at Beadnell, Scremerston, Howick, Haltwhistle,* and also in flaggy beds of the millstone-grit at Berlin Carr, between Alnmouth and the Coquet.

Fig. 1.—Upper surface; the keel-like centre is that portion of the body not covered with cirri.
Fig. 2.—Section showing the articulations of the body; *a*, intestinal canal; *b*, muscular layer and articulations; *c*, space occupied by cirri.

CRASSOPODIA MEDIA (TATE). Plate II. figs. 3, 4.

Length considerable (upwards of three feet, nine inches); usual width about four lines; some specimens are only three lines, others as much as six lines wide; thickness three lines; width of body two lines; length of cirri one line and a half, twenty of them in the space of one inch; the width and thickness continue the same throughout the entire length.

It occurs in irregular loops and long undulations which occasionally cross each other, and is quite distinct from the *C. Embletonia*, being much smaller and much thicker in proportion to its size; the cirri are less crowded and the foldings are more tortuous and irregular.

It occurs in sandstone at Beadnell, abundantly at North Sunderland, at Newton-on-the-Moor, and at Howick.

Fig. 3.—Upper surface.
Fig. 4.—Section showing the cirri and a cast of the body.

NEMERTITES (McLEAY).—A Genus which has been described from the Silurian formation; it is thus defined:—Body very long, linear, slender, of nearly uniform thickness throughout, without distinct articulations.

---

* On the Irthing, near Combe Crag.

NEMERTITES UNDULATA (TATE). Plate II. fig. 5.

Length unknown (upwards of nine inches), body round, half a line in diameter, usually in loop-folds from a quarter to half an inch apart; neither articulations nor cirri are observable.

This species is generally found where fossil worms appear; it occurs in sandstone at Beadnell, North Sunderland, Howick, and Haltwhistle.

Fig. 5.—Nemertites undulata, accompanied with borings of other annelids; this species also is figured on the slab, fig. 6.

EIONE (TATE).—This annelid, very different from every other, occurs in considerable abundance at Howick, in a thick flaggy sandstone which holds a similar relative position in the mountain-limestone series to some of the sandstone-beds at Beadnell. This fossil, too, is associated with the same species of worms as are found at Beadnell. It has characters so remarkably distinct that I have provisionally given it a generic as well as a specific name.

EIONE MONILIFORMIS (TATE). Plate II. fig. 6.

Length unknown (upwards of three feet); body rounded, lower surface and sides moderately convex, smooth, upper annulated, diameter six lines; articulations consisting of bead-shaped rings on the upper surface, distinctly separated from each other by a deep sulcation, the length of each articulation being five lines; it occurs in long undulations. Some individuals are a little larger and others a little smaller than the size stated; but each preserves the size and character throughout the entire length. I have been unable to detect any internal structure, or to observe setæ, cirri, or appendages.

This very peculiar fossil worm may be referred to Cuvier's order Abranchiata. Destitute of setæ and cirri, it resembles the *Hirudo* or leech, and probably, like the *Lumbricus* or earth-worm, it respired by the entire surface of the skin and not by special organs; it would progress by the contraction and extension of the subcutaneous muscular stratum.

It is found at Howick, Scremerston, and Haltwhistle in Northumberland, and I believe also in Yorkshire.

Besides the forms now described, there are other casts and trails at

Beadnell. Some seem to be the burrows or casts of annelids, passing either perpendicularly or obliquely through several layers of rock, the upper surface of the layers being pitted and the under projecting. These casts or burrows are about two lines in diameter, and are so crowded together in some rocks both at Beadnell and Kirkwhelpington, as to give the stone a pock-marked appearance. Meandering furrows about one line in width, with a ridge in the centre, are probably the trails of an annelid: they occur also at Howick, North Sunderland, and Haltwhistle. It has been suggested that these were tracks made by small crustaceans, but the absence of all remains of the hard shell renders this opinion doubtful, and more extended observations on these borings and trails, and on the other markings associated with them, are required before the true characters can be distinctly determined.

As confirmatory of the marine conditions of the rocks in which the ripple-marks and annelids are found, I may add, that the flaggy sandstone containing annelids at Howick has in some of the layers *Bellerophon*, *Euomphalus*, *Murchisonia*, and *Pleurotomaria*, shells undoubtedly of marine origin.

The group of facts now noticed gives us a partial glimpse into a far distant era. The Beadnell flaggy beds expose to our view an ancient coast-line: we hear the waves breaking on the shore; we perceive currents rolling along masses of sand; the tide recedes, and ripple-marks, long ridges and furrows, sharp and distinct, appear; there, too, are seen worms, some of large size, crawling over the surface or burrowing in the sand. Marks left by the sea are often fugitive,—the impressions made by one tide are obliterated by another; but here they are preserved; the sand and mud are hardened, it may be, by a warm sun breaking forth and baking the surface before the return of the tide; other deposits have covered over the markings, and buried up and preserved the organic forms; and now, when these rocks are laid bare and examined, they reveal to us that the same physical laws operated during the Carboniferous Era as at the present time, and that, though the aspects of vegetation were wonderfully different, and organic life specifically distinct, yet the animals of the period were formed according to the same types, and were subject to like conditions as those now existing.

Before leaving the stratified rocks, allusion may be made to the illustration they afford of changes of physical condition and of oscillations of level. Taking the coal in connexion with the limestone, there is evidence of not less than fourteen changes of level; as many times, during the period when these rocks were being deposited, the district was clothed with an abundant and marvellous vegetation,—as many times were there alternations of swamps and lakes, of estuaries and lagoons, and of seas sometimes profound, though generally of moderate depth.

A little northward of the basaltic dyke, a narrow crack or fissure of the sandstone contains galena or sulphuret of lead. It runs across the strata from south by east to north by west; and a branch from it forks off to the north-north-west. The vein seems too small to be worked with advantage. Its position gives probability to the theory that the igneous agency which forced upward the basalt produced also, by sublimation, the ore which is found in the vein.

When viewed from the shore near to Dunstan Square, this basaltic dyke, even to one unacquainted with geological principles, is a striking and interesting object. It rises perpendicularly through the stratified rocks, and runs in a direct line from west 85° south to east 85° north. Its width is twenty-five feet, contracting seaward to twenty feet. It stands in some parts ten feet above the strata, and appears like a wall rudely piled up by Cyclopean builders; and, although in other parts it is broken down by the waves, its course can be distinctly traced for a considerable distance into the sea. The basalt is of the usual composition, augite and felspar; but it is finer grained than the larger masses at Ratcheugh and the Farne Islands. The adjacent strata are very slightly altered in position; but their structural characters are changed. Coal for some distance from it is valueless; limestone near it will not burn into lime; and shale and sandstone are indurated. At the point of contact, sandstones, shales, and limestones are much jointed and fissured, and assume the external form of basalt; on the other hand, the basalt itself becomes calcareous and siliceous. This transference of qualities and the structural changes superinduced are the results of the igneous agency which, by its upward pressure, rent asunder the vast mass of stratified rocks, and then poured the molten basalt into the fissures.

THE GEOLOGY OF HOOK POINT.

By Professor R. Harkness, F.R.S. F.G.S.

(*Continued from page* 32.)

The paleontology or the study of the fossils of Hook Head is, if it be possible, even more interesting than its physical geology. As soon as ever we cross over the sandstones, and ascend into the higher strata of the Carboniferous series proper, we reach a domain abounding with animal life. Almost immediately above the sandstones which afford the remains of the fossil plants, we reach a zone having a distinct mineral character. This zone consists of a black shale, a substance which was originally black mud deposited by the sea, and this black shale is an important member of the great Carboniferous series of the south of Ireland. At Hook, it is a very degraded form of that member of the Irish carboniferous series known under the name of "carboniferous slate." In this locality it has a thickness of only a few yards, but westward from Hook the carboniferous slate increases in thickness, until we find it in the county of Cork, separating the sandstone strata below from the lower portion of the carboniferous limestone above, by an interval, in some instances, reaching to about 4,000 feet. At Hook, this ancient muddy sea-bottom seems to have existed for a shorter time than towards the westward, and was succeeded by a sea containing a considerable portion of lime in its waters.

The limestone which succeeds the black shale at Hook is not of so pure a character as that which forms the general great mass of the Lower Limestone of Ireland. It is largely impregnated with mud, and seems to have resulted from nearly the same physical conditions as the inferior black shale, differing only from the latter in containing a greater amount of lime. The black shale and the limestone equally afford fossils, and they show us to what an extent animal life abounded in the seas during this early geological period. All geologists conversant with Carboniferous fossils are not only aware to what an extent many of the forms of life of this period abound in this locality, but likewise know the perfection of the Hook organisms. Among zoophytes—those plant-like animals which, in external form, nearly approach to vegetables, but which in their portions possessing the power of sensation have the simplest animal organization—we find the *Astræopora*, with its slightly convex surface covered over with stellate pores, the former abode of the numerous-headed animal which constructed the strong fabric forming its habitation. Here, too, occurs the *Aulopora*, with its chain-like form, spreading itself over the surfaces of shells, and studded on its upper side with numerous apertures from whence issued the heads of its occupant. The *Michelinia*, with its surface covered with depressed stars, arranged in an hexagonal form like an antique pavement, here, too, makes its appearance in considerable abundance; *Stenopora*, with its branching form and rugose surface, here also occurs; and among them also we find *Zaphrentis*, which, when broken perpendicularly, exhibits a structure like a series of small funnels piled one upon another in its interior.

Hook Head is, however, more famous for its Crinoids—those ancient stem-like stone-lilies endowed with animal organization, and which flourished in such great abundance in many of the paleozoic seas; numberless fragments of these forms occur, for the most part in the state of fragments of stems; sometimes in the form of the cup-plates, and instances are not uncommon of almost perfect specimens being found.

One of the forms of crinoids, *Actinocrinus*, makes its appearance generally in the condition of detached plates; sometimes we have the cup in a state of perfection showing the base composed of its three pieces of quadrangular form, surmounted by numerous hexagonal plates, and terminated by arms which branch in a dichotomous manner. *Cyathocrinus*, too, occurs here, with its cup-base composed of five pieces supporting five other larger plates, which form the principal mass of the cup, and the base from whence the arms emanated. *Platycrinus* also abounds, with its base composed of three plates, surmounted by five larger pieces, which immediately support the base from whence the dichotomous ones arise. *Poteriocrinus*, with its five basal pieces, and its five subradial fragments, and long branching arms, here is met with. *Rhodocrinus* also is seen, with its numerous plates beautifully fitted together, and looking, in some species, like a rugose seed studded over with tubercles. It frequently happens that here we meet with an individual crinoid in which the stem, cup, arms, and thin net-like membranes retain all their original perfection, and they appear as if they had been suddenly enveloped in some rapid deposition of mud, while they were resting from their labours and digesting the food which their membraneous extremities had caught. In some instances the stems are in such a condition as to allow us to judge of the arrangement of the joints composing them, as also of their flexibility. The surfaces of some of the strata are covered by these stems, and sometimes the stems have such a sinuous and convoluted aspect as to lead to the conclusion that these crinoids covering the bottom of the carboniferous sea, moved about under every influence of wave and current, as trees do on land when a breeze is powerful enough to shake them. Hook Point is equally celebrated for the remains of that tribe of animals which is known under the name of Bryozoa, and which in their internal structure have great affinity to animals constructing and inhabiting bivalve-shells. Among these we have *Diastopora*, a parasite, which lived and built its habitation on other Bryozoa, forming a small patch of calcareous matter, having cells with semicircular apertures pointing outwards. *Glauconome*—one form of which presents a feather-like aspect, having a central shaft, from whence issue numerous obliquely placed bars, running together regularly, and leaving interspaces of an oval form, the bars having on one side a row of pores along each margin—is seen in considerable profusion. *Polypora*, a net-like form, having its under surface devoid of pores, but with the upper surface covered with several rows of cells on each of the upright bars, also appears at Hook Point. The form of Bryozoa which occurs in the greatest profusion and perfection is *Fenestella*. Several distinct species here make their appearance, and in some cases the limestones appear to be almost altogether made up of this form. It has a window-like aspect when magnified; but, seen without the aid of the microscope, has somewhat of a net-like structure; its under surface, like the Bryozoa generally, is devoid of pores; but the thicker upright bars have commonly a finely striated surface. The upper side of the bars is usually marked by a central, well-exhibited keel, and on the outer side of this are the numerous pores from whence the heads of the animal inhabiting the Fenestella issued. The thin cross-bars which serve to connect the thicker porebearing portions, have no pores on them, and they form, by their junctions with the thicker bars, a series of quadrangular interspaces, which give to this form the aspect from whence it derives its name. These ancient Bryozoa, or Sea-mats (Polyzoa of some authors), seem to have been strewn over the bottom of the carboniferous sea in this locality in such profusion that they now constitute by far the largest portion of the organic remains of the limestone of Hook Point.

Several forms of shells are met with among the fossils of Hook Point, but these are by no means so abundant as the Bryozoa; neither do they occur in such profusion as in many other localities of the Carboniferous Formation, as this is developed in other parts of Ireland, or in some of the areas of Great Britain where these deposits appear.

There is one circumstance in connexion with the fossils which occur in the limestone of Hook of much importance,—this is the fine state of perfection in which they are seen. The Bryozoa stand out in beautiful relief from the mass of the dark-coloured matrix which contains them. The calcareous habitations of these ancient occupants of a former sea have a white bleached-like aspect, which contrasts strongly with the dark limestone, and adds much to the interest of these ancient remains. The soft nature of the imbedding matrix is the origin of this beauty and perfection of the fossils. The clayey limestone yields easily to the influence of the sea, and portions become decomposed and separated from the organisms which are contained therein, allowing these latter to present themselves in a state of high relief, and affording to the paleontologist opportunities of obtaining a knowledge not only of the dwellings, but also of the bodies, of the creatures which fashioned these stony abodes.

These antique records of an early epoch in our earth's history, from whence we obtain a knowledge of some of the creatures which have enjoyed "their little all of life" in seas of ancient times, speak to us of periods so long and so remote, that the mind fails even to grasp the amount of time consumed during their existence as species upon our planet. Man measures his periods by motion; he counts his days, and months, and years by the revolution of his earth and those celestial bodies which are the companions of his world in "heavens with hollowness." Days, and months, and years rolled by in periods long antecedent to man's advent upon this earth: the sun gilded the rippling waves of ocean as he rose from his eastern couch, and purpled the sea as he sank behind its western waves: the silvery light of the crescent moon danced on the wandering surface of the waters, and the tremulous sea, "meek as a slave before his lord," silently followed the bidding of night's pale queen in this far-off geological epoch;—but sun and moon are alike silent when we question them as to the times and seasons at which these "sea-mats" of the Carboniferous Period were living things sporting in their beams. Motion entirely fails to convey to us any knowledge concerning geological epochs. These epochs are written only in the lives of species; and how long conditions suitable for forms of life obtained, is still a question of which even the elements for calculation are not yet arrived at.

ON THE ANTHRACITE-COAL OF SOUTH WALES.

By Dr. J. P. Bevan, F.G.S.

There is probably no mineral, of all the many that contribute to England's commercial greatness, which is so varied in kind, chemical composition, and appearance, as coal; and an interesting volume might be written on the different forms under which it is extracted from the earth, under the names of brown-coal, culm, cannel-coal, bituminous coal, anthracite, and the like. Next to the bituminous coals of Great Britain, the most important are the anthracites or stone-coals; and of these I propose to give a short sketch, especially as relates to their development in the coal-basin of South Wales. Of their importance commercially there can be no doubt: for, on referring to the "Mining Records" published during last year, I find that 960,500 tons were raised in this basin alone, for the purpose of supplying 18 blast-furnaces in the counties of Brecon, Glamorgan, and Caermarthen.

The peculiarities of anthracite have been known for a very long time; for even old Leland speaks thus of it:—

"At Llanelthle, a village of Kidwelli Lordship, a vi miles from Kidwelli, the Inhabitans digge coles, elles scant in Kidwelli Land. Ther be ii manner of thes coles—Ring-coles for smith be blowid and waterid—Stone-coles be sometime waterid, but never blowen; for blowing extinguishit them—So that Vendrith Vawr coles be stonecoles—Llanethle coles Ring-Coles."

Again, in 1595, Thomas Owen, the antiquary and historian of Pembrokeshire, writes concerning it:—

"It is called stone-cole for the hardness thereof, and is burned in chimnies and grates of iron; and, being once kindled, giveth a greater heate than lighte, and delighteth to burn in dark places. It servith alsoe for smithes to work with, though not soe well as the other kindes of cole, called the running cole, for that, when it first kindleth, it melteth and runneth as wax, and groweth into one clodde; whereas this stone-cole burneth aparte and never clyngeth together. This kind of cole is not noysome for the smoke, nor nothing so loathsome for the smell, as the ring-cole is, whose smoke annoyeth all things near it, as fyne linen, men's handes that warm themselves by it; but this stone-cole yieldeth in a manner noe smoke after it is kindled, and is soe pure that fine camerick and lawne is usually dried by it without any stayn or blemish, and is a most proved good dryer of malt, therein passing woode, ferne, or strawe. This cole, for the rare properties thereof, was carried out of this countrie to the citie of London, to the late Lord Treasurer Burley, by gentlemen of experience, to show how far that excelled the same of Newcastell wherewith the citie of London is served; and I think, if the passage were not soe tedious, there would be great use of it." Thus spake Mr. Owen, who was evidently an observant man, and far ahead of his time.

The distribution of the anthracite in the South Wales basin is unequal, there being no actual line of demarcation between it and the bituminous coal; but, on the contrary, a change so gradual that it is difficult to fix the precise spot where the anthracite tendency first shows itself. This peculiarity is not limited to this district, but is observed also in the coal-field of Donetz in South Russia, as also in the Pennsylvanian field. The north crop of the South Wales basin (which, by the way, is more of the shape of an elongated trough than of a basin) extends from the Blorenge Mountain, near Blanafou, to the Caermarthenshire coast at Kidwelly; a distance of between sixty and seventy miles, the latter half of which gradually curves southward to meet the south crop at the narrow end of the trough. At Blanafou, where the measures turn the corner from Pontypool, the coals are wholly bituminous, as they are also at Clydach, Nantyglo, Blaina, Beaufort, Ebbwvale, Tredegar, and Sirhowy, all iron-works supplied by these north crop or lower-measure coals. The next work to Tredegar is, however, Rhymney (ten miles or so from Blanafou), which is divided by the river of the same name into Rhymney proper, and Bute on the Glamorganshire side. Why I am particular in specifying this is, because at Bute appears the first evidence of an anthracite tendency in the coal, although but slightly marked. The next valley, or that of the Taff, contains Merthyr Dowlais and Cyfartha, where the bituminous or coking quality is still decreasing, and the anthracite takes its place. Further westward, at Hirwain, the tendency is about equal to that of the Cyfartha coal, although the latter is superior for melting purposes, explained by Mr. Mushet by the mode in which the anthracite material exists,—that of the Cyfartha coal being diffused and penetrated by a bituminous cement, while that of Hirwain is in distinct leaves. At Onlwyn, nine miles from Hirwain, the seams are altogether anthracitous, as they are also at Ystradgunlais in the Strausen Valley, Cwm Amman, and the whole of the Caermarthenshire north crop, until we reach the sea at Kidwelly, where are situated the "Vendraeth Vawr," or "stone-coles" of old Leland.

For a long time, the principal use of anthracite was for melting, for which process it was always available, and for which it is still employed; indeed, there is a seam of coal worked in Cwm Amman, the "Big Vein," which is almost exclusively used for this branch of trade, which consumes 50,000 tons of anthracite annually. But as regards the iron manufacture, it was looked upon as rather a nuisance than otherwise; for, so far from conducing to good combustion, it almost put the fire out, and thus was worse than useless. In 1837, however, a Mr. Crane set up a furnace at Ystradgunlais in the Strausen Valley, and endeavoured unsuccessfully to make iron with this coal. He then tried the experiment of mixing anthracite with bituminous coal from other districts, by the help of which he succeeded in smelting the iron, though not profitably, as the expense of bringing other coals would not allow of competition with works where everything was on the spot. But one evening, when he was sitting by his fireside, he observed that a lump of anthracite, instead of catching the flame and burning up readily, actually deadened it, and by slow degrees was putting it out. He saw at once the utter uselessness of cold anthracite in the furnace, and proposed to heat it preparatory to using it in the blast. Fortunately for the district, he was entirely successful; and thus opened up a fresh portion of South Wales to commercial enterprise. There is, however, one drawback still about it, and that is, the slowness with which the iron is turned out, in comparison with the iron of the bituminous works; a cause which operates somewhat detrimentally, when we consider the great extent of competition in the trade.

The chemical features of anthracite may be summed up in a very few words. As compared with bituminous coal, its great difference is in containing much more carbon and less volatile matters. I add an analysis made by Dr. Schafhaeutl, which was published in the "Transactions of the Royal Institute of South Wales" for 1840. It is as follows:—

Carbon	92.79
Hydrogen	3.14
Oxygen	1.64
Azote	0.89
Silica	1.13
Alumina	0.32
Sulphur with traces of Iron	0.09
	100.00
Density	1.349

In the following tabulated columns I have appended a short analysis * of the coals in their westward course along the north crop, showing the gradual increase of the anthracitous matter.

Tabular Columns showing the Increase of Anthracite to the Westward.

	In 100 parts.			In 100 parts.	
	Carbon.	Bituminous Matter.		Carbon.	Bituminous Matter
1. *Blanafou*—			3. *Nantyglo*—		
Three Quarter Coal	65.63	31.25	Ellid	81.87	17.13
Droydeg	65.55	28.95	Three Quarter	82.65	15.10
Meadow Vein	72.00	26.00	Bydellog	77.14	17.86
Old Coal	75.21	22.29	Old Coal	78.75	18.75
2. *Clydach*—			4. *Ebbwvale*—		
Ellid Coal	76.58	20.80	Ellid	82.32	16.30
Big Vein	73.42	24.58	Three Quarter	80.25	17.00
Three Quarter	72.70	25.30	Big Vein	81.37	17.00
Bydellog or Droydeg	72.13	21.87	Bydellog	72.88	16.87
Yard Vein	78.68	19.32	Yard Vein	81.04	15.83
Old Coal	77.55	18.95	Old Coal	79.28	18.22

---

* Selected from those made by Mr. Mushet.

	In 100 parts.	
	Carbon.	Bituminous Matter.
5. *Rhymney*—		
Big Vein	82.33	13.17
Ras-las or Bydellog .	82.79	12.96
Yard Vein	80.92	16.20
Four Foot Coal . .	80.15	15.10
Red Coal	84.25	12.75
6. *Dowlais*—		
Big Vein	85.00	11.87
Ras-las	85.02	13.23
Upper Four Foot .	85.75	12.75
Cwm Cenol	88.63	9.74
Little Vein	86.90	11.72
7. *Cyfartha*—		
Big Vein	90.28	7.97
Cwm-ddu	88.78	9.22
Cyfartha, cont.—		
Cwm-mwyn	88.87	9.00
Crom-y-gls	89.29	6.58
Gelly-deg	91.86	6.14
8. *Hirwain*—		
Big Vein	88.94	7.18
Four Foot Coal . .	90.26	7.86
9. *Onlwyn and Neath Valley*—		
Eighteen Foot Coal .	91.43	6.24
Nine Foot Coal . .	93.12	5.22
10. *Swansea Valley*—		
Big Vein	92.89	5.61
Brass Vein	92.46	6.04
Black Vein	93.14	5.36

The next point is rather a *quæstio vexata*, viz. the causes which have produced anthracite. Many geologists consider the causes to be purely chemical, and that they are in action at the present time,—causes involving the existence of an immense internal heat, which is gradually changing the whole basin. Dr. Schafhaeutl considered that the anthracite was altogether a distinct and separate formation; that it never was bituminous, but that it derived its distinctive features from a different chemical composition of the original vegetable matter. I cannot myself agree with either of these theories; nor do I consider that the cause of the change was chemical, or that it is still in progress. With the second hypothesis I still less agree; for under the seams of anthracite-coal we find the same underclays as underlie the bituminous seams, proving, at all events, that the same conditions of soil and growth existed in one as the other; added to which, I have frequently found in the anthracite fossil plants identical with those of the bituminous coal, the only difference being that the former appear to have been subjected to greater heat.

The facts, too, which I have stated about the gradual commencement at Rhymney, and the subsequent increase of the anthracitic condition, do not seem to be compatible with the totally distinct chemical operations. It is generally stated that the proximity of trap-rocks, &c. is a common cause of the change to anthracite. In the South Wales basin there are no visible trap-rocks (except in Pembrokeshire, where they have nothing to do with the present question), but, nevertheless, I cannot help imagining that the changes have been caused by trap-rocks far below the surface, which have never appeared; and that the gradual disappearance of the anthracitic tendency has been simply the diminishing distance from the heat which has caused the change. The question may be asked, Why are only the "North Crop coals" anthracitic, while the "Upper Measure coals," which are worked only a few miles distant, are bituminous? For instance, at Trimsaran, near Kidwelly, the coals are stone-coals, while at Llanelly, only six miles distant, the coals (upper measure) are bituminous. I consider the reason to be that the changes were subsequent to the deposition of the lower measures and prior to the upper ones; for we must not forget the vast geologic times that passed between the formation of the upper and the lower measures, during the deposition of the immense thickness of Pennant rock. According to this notion, the anthracitic change was all completed before the deposition of the upper measures. If the change were going on now, I cannot understand how the upper measures, which are so near the seat of change, can escape the same effects. In addition to what I have stated, I may add that in all the accounts of anthracitic coal-fields which I have looked through, whether belonging to the old coal-period or to the secondary eras, I have observed that disturbances and the presence of igneous rocks are described as existing in the great majority.

FOREIGN CORRESPONDENCE.

By Dr. T. L. Phipson of Paris.

Shifting Sand-hills of the Mediterranean—Sand-hills or Dunes on the Coast of Flanders—Encroachment of the Sea—Vegetation of the Dunes—Subterranean Noises—Crystalline forms of Anglesite—Analysis of a Meteorite—Minerals in Aerolites—Meteoric Stones and their relations to Geology—The Volcano in the Island of Bourbon—Temperature of the Earth's crust at inconsiderable depths—Activity of Mount Vesuvius—Earthquakes in Turkey—Submarine Volcano near Leghorn—Erratum: Iron-alum.

The learned Geologist of Montpelier, M. Marcel de Serres, has just communicated to the Paris Academy of Sciences the following facts concerning the dunes, or shifting sand-hills, of the French Mediterranean coasts. These sands are first thrown upon the shore by the sea; when dry, they are carried inward by the winds, to the distance of several kilomètres, covering fields and vineyards to the depth of two or three feet, suffocating vegetation, and transforming the richest cultivation into a desert waste.

The only effectual means of counteracting this evil is to plant tamarisks along the coast, so as to form a barrier. But instances are frequent where neither plantations nor walls have been sufficient to prevent the sands from covering roads and fields. Last August two houses, several storeys high, about a mile from Agde (Hérault), were completely buried under the sands. The houses happened to be uninhabited at the time, so that no lives were lost; fortunately also a north wind succeeded to the opposite one which had brought the sand, and blew it away again.

M. Marcel de Serres, in studying this phenomenon, has observed that these shifting sands form two distinct zones: the first, consisting of very fine sand, contains very few shells or scarcely any organic matter; the second contains a large proportion of shells, rounded shingle, and fragments of rock. This second zone remains near the coast, whilst the former one is carried inland, as before stated. Notwithstanding their disastrous effects, these sands, when mixed with rich mould, make an excellent soil for growing vines.

In a former number of THE GEOLOGIST we intimated that we would return again to the geology of the Belgian shores. The short note of M. Marcel de Serres furnishes us with the occasion of adding a few more remarks on the sand-hills of the coast of Flanders. These too, in spite of the influence of vegetation, have encroached upon the land to a considerable extent, and gradually progress each year a little towards the interior. It is a well-known fact that the town of Ostend originated in a little village, or rather in a few fishermen's huts, built *behind* the dunes, which protected them from the strong winds, but at the present day Ostend stands out into the sea. It holds its ground, although the town is considerably below high-tide level, by means of a magnificent pier, built of the black limestone of Tournay, and constantly kept in good repair. In other localities upon the Flemish coast the sea has encroached dangerously; for instance, in the Dutch village of Scheveningue some of the buildings are washed by the waves.*

The only means of impeding the sand-hills in their destructive progress consists in promoting the growth of certain plants on the dunes. Three or four plants are particularly beneficial in this respect, as regards the coast of Flanders; and botanical remarks upon this coast will be likewise applicable to the sandy portions of the English shores. They are certain grasses, especially *Elymus arenarius* (Upright Sea Lyme-grass) and *Arundo arenaria* (Sea Reed), the long creeping roots, or rather rhizomes of which bind the sand together, furnish it with organic matter, and continually send forth young vigorous shoots. To these may be added *Triticum junceum*, *T. loliaceum*, *Hordeum maritimum*, *Poa maritima*, *P. bulbosa*, and *Rottbollia incurvata*, the last a beautiful and rather rare grass, which becomes towards autumn of a deep yellow colour, gradually blending into a bright crimson; besides these are certain species of *Salsola*, *Beta*, *Galium*, &c. among the dicotyledons which flourish upon the dunes or near the sea, especially where there is mud as well as sand. To them we must add two ligneous plants, which contribute more than any others to fix the movable sand of the dunes we speak of; the one is a stunted willow, *Salix cinerea* (or a variety), with ash-coloured leaves; the other, a remarkable plant, called the Sea-buckthorn (*Hippophæa rhamnoïdes*), is a thorny shrub, some four or five feet high, bearing a bright orange-coloured berry, like that of the holly.

---

* With respect to these remarkable changes, consult the valuable work of MM. Belpaire, entitled :—*De la plaine maritime depuis Boulogne jusqu'au Danemark, &c., par MM. Antoine et Alphonse Belpaire.* Anvers, chez Max. Kornicker.—T. L. P.

Some of these, and many other plants which we cannot mention here,* might be cultivated with advantage on the sand-hills. Indeed, such has long been my conviction, and in 1855 I intimated to the Belgian Government that the cultivation of maize or Indian corn, for its starch, in the more fertile parts of the dunes of Flanders, might meet with success.† Some years ago I called attention‡ also to this fact, that, if we consider a soil composed of pure clay, another of limestone or chalk, and a third of sand, it will be found that of these three, the one composed of pure sand is the most favourable to the development of vegetables. But the sand of the Flemish dunes is not quite pure; it is mixed up with a considerable quantity of *débris* of shells, the fragments of calcareous matter being reduced to the size of the grains of sand; it reposes upon a sort of marl,—the well-known *Argile grise d'Ostende*, which in some places lies bare upon the sea-shore; so that with a little trouble the movable sand-hills might be converted into a fixed and fertile soil, containing all the necessary elements,—sand, carbonate of lime, clay, organic matter, salts, &c. Add to this the purity of the maritime air, the presence of minute quantities of salt§ and iodide of sodium‖ in the sand, or, at least, this iodide is found in the plants of the dunes, though some say it has never been discovered in the sand on which they grow, and we shall not be so astonished at the remarkable fertility which some of the more favoured spots of these sand-hills present to us.

---

* Amongst others a peculiar species of "Old Man," (*Artemisia maritima*), Sweet-briar, some species of *Solanum*, *Viola*, *Lotus*, *Linum*, *Daucus*, &c.

† See my *Mémoire sur la Fécule et les substances qui peuvent la remplacer dans l'Industrie.* Bruxelles, 1855-6, J. B. Tircher.

‡ *Journal de la Société des Sciences Médicales et Naturelles de Bruxelles. Oct.* 1854.

§ On the uses of salt in agriculture, see an excellent prize essay by my friend Dr. Max. De Saive, of Brussels, founder of the Veterinary School of Medicine at Liége, entitled "*Mémoire sur les usages du sel en Agriculture*," and to which the Brussels Academy awarded their gold medal some years ago.—T. L. P.

‖ A curious experiment was made some time since by M. Blengini, upon the effects of iodine and bromine on vegetation. Some seeds were found to germinate with astonishing rapidity if they were sprinkled over with a slight quantity of a solution of iodine, or iodide of sodium.—T. L. P.

In one of the late numbers of the *Times* appeared a letter (Nov. 9, 1858), written by a variety of the species *Anonymus incognitus*. The writer declares that his attention has frequently been called to certain low, sullen, subterranean sounds, which he has likewise heard himself, on the coast of Wales (Cardiganshire). These sounds resemble the report of distant artillery. I notice this, as I have likewise heard similar noises on the coast of Flanders, whilst reposing, during a bright summer's day, on the dunes near Ostend. The sounds, which I had heard before, and attributed to distant cannon, I noticed again last summer, when they were pretty nearly of the same intensity as formerly, and resembled the low sullen reports of very distant artillery; but none was at that time active in Belgium, and we have no reasons to suppose that the noise arose from guns at sea.

In connexion with this, I find in a little work lately published,* a chapter called "*Sounds from the Sea*," commencing thus:—"In the west coast of England a particular hollow noise on the sea-coast is known always to foretell the approach of a very heavy storm." Now, unluckily, I do not happen to recollect if any storm or bad weather followed closely upon the sounds I heard on the coast of Flanders. I believe not, nor does the writer in the *Times* allude to any such circumstance.

In the year 1844 the Polytechnic Society of Cornwall published a report, in which the writer says:—"In Mount's Bay, and probably in all places similarly situated, there is often heard inland, at a certain distance from the shore, a peculiar hollow, murmuring sound, locally termed 'the calling of the sea,' which, if proceeding from a direction different from that of the wind, is almost always followed by a change of wind, generally within twelve hours. . . . It is heard sometimes at a distance of several miles, although on the shore from which it proceeds the sea may not be louder than usual. . . . This sound must not be confounded with that arising from a 'ground-sea,' which is the well-known agitation along the shore occasioned by a distant storm; . . . . for this latter noise propagates itself in every direction, and chiefly in that of the wind, whereas the 'calling' is heard only in one direction, and usually contrary to the wind." The writer of this report believes the noise to depend upon "a certain condition of the atmosphere," regards it as a forerunner of certain changes in the weather, and calls it "a very common but not generally known" phenomenon.

That the noise last spoken of is the same as that described by the writer in the *Times*, and that which I have myself heard two or three times on the coast of Flanders, there can be little doubt; but as to its cause I am perfectly ignorant, nor am I inclined to attribute it to "certain conditions of the atmosphere." It may probably have some connexion with the rumbling subterraneous noise so frequent during earthquake phenomena; and these latter frequently appear to exercise a certain influence upon the weather.*

---

* M'Phun's "*Weather Indicator*," dedicated to Prof. Nichol. Glasgow, 1857.

M. Von Lang has recently made known to the Imperial Academy of Sciences at Vienna the great variety of crystalline forms that sulphate of lead (*Anglesite*) is capable of taking in nature. Although isomorphous with sulphate of baryta (*Barytine*) and sulphate of strontia (*Celestine*), Anglesite possesses a far greater variety of forms than either of these two minerals. M. Von Lang, taking advantage of the immense number of samples of Anglesite existing in the Vienna collections, has written upon this substance a considerable monograph. The number of different crystals (all derivable from one type) of which he has measured the angles, amounts to more than 150.

M. Buckeisen, a pupil of M. Wöhler, the distinguished professor of chemistry at the University of Göttingen, has analysed a meteoric stone which fell on the night between the 10th and 11th of October, 1857, not far from Ohaba, a village situated near Kalsbourg, in Austria. This stone has been placed by Dr. Hörnes in the collection of the Imperial Institute of Geology at Vienna. It was seen to fall by a Greek priest, Nicolas Maldowan, about midnight on the 10th of October: the noise which accompanied its descent was like a loud clap of thunder. It fell with the quickness of lightning, and sank some distance into the ground at a spot covered with moss. Its weight is about 30 lbs.; its specific gravity 3.11, and it has a pyramidal shape. On being broken, it showed (by the aid of a magnifying glass), in the fractured part, crystalline grains of olivine, of metallic iron, and of magnetic oxide of iron. From M. Buckeisen's analysis it appears to consist principally of olivine, augite, a mineral analogous to Felspar, pure iron, and sulphuret of iron.

---

* With respect to sounds resembling artillery, the utmost caution should be used, from the distance at which guns can occasionally be heard. I have distinctly heard the practice-firing at Woolwich from the downs behind Folkestone; and at that town the salutes from the forts at Boulogne, thirty-two miles off, are perfectly audible. I remember hearing, while walking on Dover pier, the low rumble of the bombardment of Antwerp by the French in 1832, the distance of which, in a straight line, I should think must be something like one hundred and thirty miles. The sounds of ships' guns are very like those described in the above article, and are audible for long distances, and the large calibre of the cannon now used increases very greatly the range of sound.

While I was sketching in Hythe church, two or three years since, the percussion of the evening guns of some men-of-war lying off Sandgate clattered the panes of glass in the windows of that fabric, which stands on a limestone-hill, and is of early English architecture, based on Norman foundations, and in good repair. These remarks are not made with a desire to invalidate the stated nature of the sounds alluded to by Dr. Phipson, and the authorities he quotes, but with the view to show the imperative necessity of the utmost caution in the observation of such phenomena.

The peculiar hollow booming of the waves on the sea-shore before a storm is too palpable to escape notice, and is generally, as far as I recollect, accompanied by a remarkable stillness, or rather silence, if I may express it, to distinguish it from any ideas of atmospheric motion,—a stillness in which the noises of various objects are unusually perfect and distinct.

The breaking of the waves when heard from behind an obstruction, such as a wall, bank, hill, or street, is sometimes not unlike the sound of guns.—Ed. Geologist.

The first discovery of minerals in meteoric stones, or aërolites, is due, we believe, to Gustav Rose and Professor Rammelsberg. This eminent German chemist has endeavoured to show in a memoir, published in Poggendorff's Annalen (lx. 130), that the residuum which remains insoluble after aërolites have been boiled in acid consists of a mixture of minerals such as are generally found in volcanic rocks on the surface of the earth. Thus, for instance, the rocky parts of the meteoric stone which fell at Château-Renard (Provence), and which was analysed by Dufrénoy, consists of a mixture of albite and amphibolite; and in the aërolites which fell at Blausko and at Chantonnay, a mixture of amphibolite and labradorite was discovered.

According to Gustav Rose* (Poggend. Ann. for 1825, 173 and 192), a meteoric stone found at Juvenas (Département de l'Ardèche) is composed of a finely granular tissue of olivine, augite, and labradorite, blended together so as to resemble dolerite. Berzelius and Rammelsberg affirm that in the well-known Siberian mass of meteoric iron, investigated by Pallas, the olivine only differs from common olivine by the absence of nickel, which is replaced by oxide of tin. As meteoric olivine, like our basalt, contains from forty-seven to forty-nine per cent. of magnesia, constituting, according to Berzelius, almost the half of the earthy constituents of meteoric stones, we cannot be surprised at the great quantity of silicate of magnesia found in these cosmical bodies.† A meteoric stone may be grey, earthy, or metallic inside; but its outside is invariably covered by a black shiny crust or rind, a few tenths of a line in thickness. This peculiarity at once characterizes an aërolite. The black crust is doubtlessly produced by a fusion of the elements of the meteorite; but, as Humboldt has justly remarked, the greatest heat of our porcelain ovens would be insufficient to produce anything similar to the crust of meteoric stones, the interiors of which remain wholly unchanged.

Whilst some aërolites contain as much as ninety-six per cent. of iron, others will be found to contain barely two per cent. The indefatigable researches of Berzelius have shown that fifteen elements may be sought for with success in meteoric stones. They are: iron, nickel, cobalt, manganese, chromium, copper, arsenic, zinc, potassium, sodium, sulphur, phosphorus, carbon, silicium, and magnesium. To these we may add tin and calcium, from what has been already stated above.

Olbers has remarked that it is a curious, but hitherto unregarded fact, that while shells, &c. are found in secondary and tertiary formations, no fossil meteoric stones have as yet been discovered. "May we conclude from this circumstance," says he, "that previous to the present and last modification of the earth's surface no meteoric stones fell on it, although at the present time it appears probable that 700 fall annually?" To which Humboldt has replied, that problematical nickeliferous masses of native iron have been found in northern Asia, at the gold-washing establishment of Petropawlowsk, eighty miles south-east of Kusnezk, imbedded thirty-one feet in the ground; and more recently in the Western Carpathians (the mountain-chain of Magura, at Szlaniez), in both of which cases they are remarkably like meteoric stones.*

---

* See also Rammelsberg, Handwörterbuch der Mineralogie (first supplement, 1843, p. 102).

† Berzelius, Jahresber. vol. XV. 217 and 231; also Humboldt, Cosmos, vol. I. p. 119 *et seq.*

The Governor of the Island of Réunion (Bourbon), in a despatch of the 8th December last, says:—"The volcano of this island is now in full eruption. Since last week a torrent of burning lava has been seen flowing towards the sea, and all communication with the Arrondissement du Vent has been cut off; the lava having crossed the high road for an extent of 400 yards, and to the depth of from nine to twelve feet." The flow of lava reached the sea on the 9th. This volcano of Bourbon is the most active of all those existing in the southern hemisphere, between the west coast of New Holland and the east coast of America. The greater part of the island, particularly the western portion and the interior, is basaltic. Recent veins of basalt, with little admixture of olivine, run through the older rock, which abounds in olivine; beds of lignite are also enclosed in the basalt.

The summit of the volcano of Bourbon, which Hubert describes as emitting nearly every year two streams of lava, which frequently extend to the sea, is eight thousand feet high. It exhibits several cones of eruption, which have received distinct names, and which alternately send forth eruptions. Eruptions from the summit are not frequent. The lavas contain glassy felspar, and are therefore rather trachytic than basaltic. The ashes frequently contain olivine in long fine threads, like that produced by the volcano of Owhyhee. A violent eruption of these glassy threads, covering the whole island of Bourbon, occurred in the year 1821.†

M. Fleurion, professor in one of the Imperial Schools of Agriculture, announces to the Paris Academy of Sciences, that, having noted for some time past the variations of temperature in the air, and at a depth of two mètres beneath the surface of the soil, he has found by comparing them, that the temperature of the earth at this depth is invariably higher by two-tenths than that of the air at the surface. It is probable that a slip of the pen has caused the author to write down two-tenths instead of one-tenth. For, taking two mètres to be (in round numbers) equal to six feet, and admitting an increase of one degree Fahr. for every fifty-four feet (English) in depth, we have:

$$54 \text{ ft.} : 6 \text{ ft.} = 1^\circ \text{ Fahr.} : x.$$

$$x = \frac{6 \times 1}{54} = 0.111, \text{ or } \tfrac{1}{10}.$$

---

* Mr. E. W. Binney has described the occurrence of three probably meteoric stones in the coal-measures of Lancashire.—*Transact. Liter. Philos. Soc. of Manchester*, vol. IX.—Ed. Geol.

† [illegible] account of a recent discovery of gold in the island of Bourbon, see [illegible] Geologist for March, 1858.—T. L. P.

The temperature of the earth, at a depth of six feet, should then, if the general law of increase of heat be observed, range only one-tenth higher than that observed at the surface of the soil, and not two-tenths, as stated above. It is a curious fact that points situated on the same vertical line, at an inconsiderable depth within the interior of the earth, experience at very different times the maximum and minimum of atmospheric temperature. Thus, Quetelet affirms, in the *Bulletin de l'Académie de Bruxelles*, for 1836, that *daily* variations of temperature are not perceptible at depths of about four feet below the surface; and at Brussels, the *highest* temperature was not indicated until the *10th December*, on a thermometer which had been sunk to a depth of more than twenty-five feet, whilst the *lowest* temperature was observed on the *15th of June*. Professor Forbes, from experiments made at a depth of twenty-four feet in the basaltic trap of Calton Hill, near Edinburgh, obtained similar results: the maximum of heat was not observed until the *8th of January*. According to Arago, very small differences of temperature are perceptible at about thirty feet below the surface. The stratum of *invariable* temperature is, in the well-known Caves de l'Observatoire, at Paris, at a depth of eighty-six feet English.

A letter from Naples informs us that "Vesuvius is cracking and splitting; the foot of the cone being pierced through and through by fumarolle, or little craters, which emit a considerable quantity of lava. . . . If this sort of work continue, the great cone, formed by the accumulation of substances thrown out by the volcano, will probably fall in one of these days; and the result will be a terrible catastrophe, not for Naples, which lies comfortably at a certain distance, but for Resina and Portici, which lie at the foot of this formidable mountain." It would certainly be a strange thing to see Vesuvius overwhelm these towns, built upon the very lava which smothered up Herculaneum. Professor Daubeny, of Oxford, the author of a well-known work on volcanos, is at present at Vesuvius.

A terrible earthquake took place in Turkey, on the 28th November, principally at Touzla, in the district of Zvornie. Many houses fell, and the inhabitants, in spite of the cold weather, were obliged to quit their dwellings and encamp in the open fields. Another still more disastrous shock has nearly overthrown the town of Ergheni, in Albania. A number of houses and shops were completely destroyed, and many people killed.

We have received some more news of the submarine volcano mentioned in our last article. The French consul at Livorno (Leghorn) has communicated the fact to the Paris Academy of Sciences. According to his account, flames and smoke were seen to issue from rocks which have taken the place of the ancient pier. All around the temperature of the sea is above boiling-point (100° Centigrade). It is evidently a volcanic phenomenon similar to that which caused the upheaval of the remarkable island called Julia, or Sabrina, not very far from the same place.

Erratum.—In my last article, in lieu of the note at foot of page 34, read,—"Most of the alum thus produced is no doubt iron-alum, *i.e.* it contains sulphate of iron, and no alumina." Sulphate of peroxide of iron and sulphate of alumina, being isomorphous salts, can replace one another in their combinations without causing a change in the crystalline form of the product. Thus, if these two salts be dissolved, they cannot be separated by crystallization: every crystal will contain both. This is often a cause of great inconvenience; for, when common alum (sulphate of potash and alumina) be mixed with, or replaced by, iron-alum (sulphate of potash and iron), it cannot be employed in dyeing, calico-printing, &c. Now, this must be inevitably the case with the alum produced by the spontaneous combustion of the coal-beds of l'Aveyron, mentioned in our preceding article, from the decomposition of the iron-pyrites

REVIEWS.

Siluria. The History of the Oldest Fossiliferous Rocks and their Foundations; with a Brief Sketch of the Distribution of Gold over the Earth. By Sir R. I. MURCHISON, &c. (Third Edition, including the "Silurian System.") With Maps and many additional Illustrations. 1859. 8vo. London: Murray.

THIS long-expected book has at last appeared, and presents a result well worthy of the care and pains that have been evidently bestowed upon it; and its handsome appearance prevents regret for any delay in its production. The printers, with good paper, clear type excellently printed, and the skill they have displayed in making the most of the numerous woodcuts with which it is illustrated, well merit the passing word of praise which the reviewer is licensed to give them.

The chief attraction of the new edition (we object to style it "the third," for the greater and original work, the "Silurian System," must then be regarded as the *first*) is in its matter. Designed as the book is to give us the history of the most remote periods of organic life upon our planet, every new word of truth which the author has elicited in the four years since he last revised his former labours—from the thick and ponderous records of the wonderful rock-masses and mountainous regions of which the Silurian region offers the types—will be looked for and sought out with eager eyes and anxious expectation. As we look with intense interest upon every trace of the first existence of our race upon this planet, and prize the intrinsically worthless flint or stone beyond the cost of gold, because some unknown human hand has chipped it into barbarous shape of arrow-head or axe, so with still more wonder do we regard the rain-prints, the worm-tracks, and the creeping things of that "long, long ago," when life first, as far as the traces of it have yet been distinctly observed, gave its great distinctive and marvellous feature to that world which "was our cradle and which will be our grave,"—the scene of all our loves, and hopes, and fears, our joys and sorrows,—linked to us by every tie of friendship and affection, and dear to us even in the days of sorrow and of tears.

It is something in such an active and intelligent world to attain eminence—to reach that point from whence we can look back or down—to be able to say we have done good service, or that we have surpassed our fellows in the intellectual race,—and so well established is the veteran eminence of Sir Roderick Murchison that we may acknowledge it without flattery or adulation; but, like as the poorer portion of humanity envy the good coat on every man's back they see, so there are some smaller minds even in scientific circles who would attempt to detract from the fame which a long, active, and useful life has fairly earned; and we are glad that, by a full and generous acknowledgment of the well-known and valuable services of the late Rev. T. T. Lewis, of Aymesbury, the author of "Siluria" has put one oft-spoken point out of the reach of his detractors.

"Ce n'est pas avec des microscopes," says De Saussure, "qu'il faut observer les montagnes;" and it is not by local or limited observation alone that a grand system like the "Silurian," as it now stands, could have been worked out. Sir Roderick is as essentially a general in science as a Napoleon or Wellington was of troops; and he could afford to give away every title to originality of detail, and yet stand a pre-eminently great man. He would even thus have accomplished a generalization and grouping of a character so extended as to have been totally out of the reach of mere local workers, had they even possessed the talents of a Barrande.

Sir Roderick has, however, been not only a successful generalizer, but also a close and keen inspector of facts, as his recent investigations and deductions regarding the crystalline strata of the north-western Highlands of Scotland and very many other instances would show; and hence his capability of judging of the value of those other labourers in the field of the earth's ancient history who have put the stores of their accumulations at his command.

We now pass to what the author of "Siluria" has done since the previous issue of his work. This is, indeed, briefly told in the preface to the book itself, and much of the most recently acquired matter is embodied in the introductory chapter.

In the first place, there is the most important section, exhibiting the lowest rocks in the British Isles as lying beneath all the oldest sedimentary and fossiliferous rocks previously known, described in the opening pages and illustrated by the delicate coloured frontispiece of the "hoary mountains" bounding Loch Assynt westward from Inchnadamff.

The oldest gneiss of Scotland, particularly on the west side of Sutherland and Ross, is unconformably surmounted by mountain-masses of conglomerate and sandstone, formerly considered as Old Red Sandstone, but now demonstrated to be of Cambrian age, from the fact of their being overlaid by quartz-rock and crystalline limestone, enclosing at Durness masses of unaltered rock, in which Mr. C. Peach, of Wick, has discovered Silurian fossils of the age of the lowest portion of the Llandeilo beds.

The identification of the Bala rocks and fossils with those of the Caradoc formation, and the determination of a passage-zone of rocks at Llandovery, connecting the Lower and Upper Silurian strata, are also new features.

The classification of the Devonian or Old Red Sandstone Formation has been improved, the Cephalaspis and Pteraspis zone being demonstrated to be the real base of this group, passing regularly and gradually downwards into the uppermost Silurian rock. Hence the Caithness flags and their extension into Ross and Moray are no longer to be considered as equivalents in age to that zone, but are referable to a middle zone or period.

During a personal excursion last summer, Sir Roderick reassured himself that flagstones, such as those of Caithness, and containing similar fishes and plants, reposed near Kirkwall, in the Orkneys, upon a lower red sandstone, and are surmounted in several of the islands by another sandstone of a light yellowish colour. In Moray, in the presumed equivalent of this yellow series which there passes up into a fine white sandstone, during the past year, most important discoveries of fossil reptilian remains have been made; Mr. Patrick Duff and others, of Elgin, having obtained casts and bones of the *Stagonolepis Robertsoni* (of Agassiz), from which Professor Huxley has been enabled to establish the reptilian nature of this creature formerly supposed to be a fish.

Additional and more highly instructive specimens of foot-tracks from the Cummingstone quarries between Burgh Head and Lossie Mouth,—first made known through the writings and labours of Captain Brickenden and Mr. Patrick Duff,—have shed additional light by the establishment of their relations to that extraordinary creature, the organization of which ranks so high as to cause many excellent geologists to suspect whether the strata in which its osseous remains, and its imprints, have been found, may not be possibly of Permian or Oolitic age; but on this point Sir Roderick expresses a strong conviction that their antiquity has been rightly stated.

The information respecting the Permian strata has also been extended by the personal examination of Sir Roderick in Germany, and by materials derived from Gubbier, Geinitz, and Göppert.

Throughout the work valuable contributions have been deduced from the labours and communications of De Verneuil, Barrande, Kjerulf, Von Keyserling, Schmidt, and others; while several valuable Tables enrich this volume over its predecessor. Of these are especially to be noticed,—a disposition, in parallel vertical columns, of the Order and Dimensions of the Silurian Rocks of England and Wales, by Mr. Talbot Aveline; a Table of the Upper Palæozoic Rocks, showing the Equivalents of the Devonian, Carboniferous, and Permian Strata, in different parts of Europe; a general Tabular View of the North American Palæozoic Rocks, by Professor Ramsay; an elaborate Table of the Vertical Range of all the described Silurian Fossils, by Professor Morris and Mr. Salter. Besides these valuable tables, numerous new sections and diagrams have been added; indeed, the whole work ranks in the highest scale for the value and elaboration of its contents.

Catalogue of Mr. Tennant's Collection of British Fossils.

This catalogue of Mr. Tennant's private collection exhibits the names of nearly all the ordinary and typical fossils of the British rocks, and a limited number of copies have been printed on one side of the paper only, to allow of their being cut up into labels.

The bibliographic list appended to the catalogue is a useful and valuable addition, and ought to aid materially the sale of the work. In it are given the titles of the best works necessary for the instruction of the student, with curt and pertinent remarks in each case of their nature and character, and of the leading topics of their contents.

Elementary Geological Diagrams. London: James Reynolds, 174, Strand.

Mr. James Reynolds, of 174, Strand, has long been known for the numerous diagrams of scientific subjects which he has published.

He has now produced, under the editorship of Professor John Morris, whose name to the work should alone be a guarantee of its worth, a set of elementary diagrams, illustrating the first principles of the important and practical science of Geology.

The series comprises an enlarged and improved general ideal "Section of the Earth's Crust," based upon the original excellent diagram in Dr. Buckland's famous "Bridgwater Treatise;" a valuable "Table of the Order and Succession of the Stratified Rocks," by Professor Morris, in which, however, we are sorry to find he continues the unfortunate misnomer of *Coralline* Crag for a deposit which contains no corals at all. If the object be to designate this bed by the nature of its most characteristic organic remains, the term Bryozoan should be applied; but it would be far better, in our opinion, to adopt the term Lower Crag for this deposit, and that of Upper for the Red Crag. The other diagrams are, "Various Forms of Stratification;" "Section of the London Basin," with springs and Artesian wells; "Carboniferous Group—Coal and Iron Strata;" "Section of a Copper Mine;" "Interior of a Coal Mine." Of these the illustrations of stratification might have been more carefully drawn, and the section of the London Basin is artificial and highly exaggerated; but we would speak of the others in favourable terms, and we shall be glad to know that such efforts to teach the great truths of science by simple and inexpensive means meet with the patronage they deserve.

NOTES AND QUERIES.

THE "CRACKERS" AND OTHER FOSSILIFEROUS NODULES.—"SIR,—I have perused the works of Mantell, Lyell, Ansted, and other standard authors on Geology, besides having regular access, through a friend, to the Quarterly Journal of the Geological Society and to other miscellaneous works on the science; but amongst them all I have not as yet been able to obtain the slightest clue that would tend to solve the undermentioned geological phenomena; and, thinking that either yourself or some of your numerous readers could throw some light upon the subject, I take the liberty of asking space for that purpose in your really popular, and, on that account, valuable periodical.

"It is a fact patent to all geologists who have visited the Isle of Wight, that its cliffs on the southern coast exhibit some good sections of the Lower Greensand, probably the best in the kingdom, more especially those between Rocken End and Atherfield Point, where this series may be studied throughout its entire thickness from the Gault to the Wealden beds.

"It is not, however, to the strata themselves that my remarks apply, but to the condition in which some of the organic remains are found in the lowermost portion termed the 'Crackers Rocks.'*

"In examining the excellent chart by Dr. Hilton, it will be seen that the 'Crackers' are composed of two layers of large nodules, one above the other, and about ten or eleven feet apart, embedded in a loose red sand. The uppermost are but little sought after by the experienced geologist, as they are very hard and tough, and the fossils they contain are very difficult to be separated from the matrix; but the lower portion contains those splendid fossils which are world-famous. The best place for the collector to search for the 'Cracker' fossils is to begin a short distance to the eastward of the road made by the coastguard in the cliff, and then to travel westward as far as another path up the cliff, made by the fishermen, where the 'Cracker-rock' runs out, and the next bed in the succession, the lower 'lobster-bed,' appears.

"After a founder of the cliff, large nodules may be found with sometimes a few fossils on their outsides; and these, when broken, sometimes disclose whole colonies of *Gervillia anceps*, with now and then *Trigonia dædalea* and an ammonite or two on the outside. The nodule itself is composed of a hard, compact, grey or bluish rock, enclosing other nodules or smooth sandy concretions, of a lightish-brown colour. These can be easily extracted, and will be found to contain myriads of small fossils, such as Venus, Thetis, Rostellaria, Natica, Pteroceras, Ammonites, Crustacea, and numerous others, nearly all perfect. Hence I infer that, like those of the lias, they all met their death in a sudden manner.

"Now the question to be solved is—How came these animals, of different genera and species, and consequently of dissimilar habits, so attracted together as to die and become entombed in one common grave? Were they all or any of them carrion-eaters; and, if so, were they attracted together by abundance of food through the destruction of any one species of animal, or by mere chance? Or did such nodules once form part of the floor of a sea-bottom, that, being broken up, yielded these concretions to be washed into the strata where they now abound, and where, becoming thus embedded, the outer coating has subsequently formed around them? If this be the case, where are the equivalents now of such concretions? Besides, the cliff is chiefly composed of sand.

---

* A local name, given them by the fishermen on account of the sea having excavated a sort of cavern in the cliffs, into which the waves enter, carrying with them a portion of air, which causes a concussion; hence the term, "Crackers Rocks."

"In conclusion, I would remark that I have merely selected the cracker-nodules in illustration of the subject; similar occurrence of concretions being repeated at intervals throughout the whole series of the Greensand strata, as at Blackgang and Clift's End. Also at Shanklin, in the nodules of ironstone, and in a greyish gritty sandstone, are many of the same kinds of fossils as at Atherfield, together with others not to be found in the 'Crackers.' Therefore, as they have all died together, the question arises, Did they all live and feed together?—Yours, &c., M. W. NORMAN."

CAUCASIAN GEOLOGY.—"SIR,—I have just read through with intense interest that best of monuments to a great and glorious spirit passed away, 'The Testimony of the Rocks,' by Hugh Miller; and in his eighth lecture, on the Noachian Deluge, where he so clearly proves 'that season of judgment' to have overtaken only the then inhabited world, 'the Low Steppe of the Caucasus,' it occurred to me, that if this were the case (which I accept in full faith, as coming from such an authority), bones of those wondrous antediluvian giants might be found in that region, and there alone. Does no geologist care to make such a search? where, too, the hidden marvels must lie so near the surface, comparatively speaking, and where the discovery would set one more seal to the truths of his wondrous science. Yours, &c., E. E. BYNG, Lymington."

The geology of the Caucasus and its vicinity is laid down in a handsome map by Koch, and has to some extent been worked out in detail by Koch, Abich, and others; but mammalian remains appear to be rare in the superficial deposits, as far as observation has yet been made in that wild country, and no fossil human bones have been met with. M. Abich, of St. Petersburgh, is, we believe, now occupied in a large work on Caucasian geology.

GEOLOGY OF SHAP DISTRICT.—"Professor Phillips, in his 'Treatise on Geology,' when describing the erratic block group, says, 'that the line followed by the blocks from Shap through Lancashire, and northward to Carlisle, is in a great depression parallel to the fault of the Penine chain.'

"1. Do the strata dip from Shap into the vale of Eden, and then rise towards the Penine chain of mountains, so as to form a trough-formed depression? 2. Or do they dip from Shap to the western or down-thrown side of the Penine fault; and then on the eastern, or upheave-side, dip away again to the eastward? 3. Is there a ridge of high ground from Orton by Ravenstonedale and Mallerstang Forest through this depression, and does its general altitude seem to be as high as the low part of the Penine chain on Stainmoor? 4. To what formations do the deposits which rest in the hollow from Carlisle to Kirby Lonsdale belong, and what is their nature?—JOHN CURRY."

1. The strata dip from Shap at a slight angle to the Craven fault, and then at an increased angle to Eden: towards the Penine fault and chain they rise again; but the stratification is not very clear in its details to the east. 2. The beds still dip westwardly on the eastern side of the Penine fault; but the strata are locally disturbed. 3. We are not personally acquainted with the physical and geological details in this district. A comparison of the Ordnance Survey and any good geological map will help the querist. 4. From Carlisle the New Red Sandstone reaches to about midway between Lazonby and Appleby; the underlying Permian beds are then exposed as far as Brough and Kirby Stephen. The Mountain or Scar-limestone then succeeds to the south-east as far as Ravensdale, where the old Silurian Schists are exposed. These extend to Kirby Lonsdale, with the exception of some intervening patches of Mountain Limestone and Old Red Conglomerate.

MAMMALIAN REMAINS.—"SIR,—In turning over the pages of old topographical books I often meet with notices of mammalian remains. If you think the extracts I have sent will serve any useful purpose in Mr. Prestwich's inquiry, I shall be pleased to furnish you with more of them from time to time.—F. S. A."

"In the cutting of some works at Eau Brink (near King's Lynn) in 1819, at the depth of twenty-two feet from the surface of the earth and in a bed of shingle, a quantity of various kinds of marine shells was found, and from thence was taken out a pair of beautiful antlers attached to the upper part of a skull, with every tooth remaining in the socket in a perfect state, corresponding exactly with the ordinary description of the roebuck. Above the shingle, in a stratum of strong ooze about ten feet thick, quantities of alder roots and trees were found."—*Historical Account of Wisbeach, by W. Watson*, 1827, p. 58.

"Some labourers, in 1819, digging for gravel in Chatteris, at a place called Campole, about half a mile from the church, found, at the depth of full ten feet from the surface, part of the skeleton of an elephant in a fossil state. The most perfect part was the two upper grinders; these, when found, were fixed in the jawbones, which the men broke to come at the teeth. A short piece of tusk about three inches long, part of the skull, part of a leg-bone about fourteen inches long, with some fragments of the jawbone, were all that were discovered. One of the grinders weighed five pounds fourteen ounces. There were found in the same place some pieces of wood quite black and spongy. In 1827 these relics were in the possession of Mr. John Girdlestone."—*Op. cit.* p. 578.

"A very fine specimen of an Elk's horn was dug up in the vicinity of West Water, in 1827."—*Op. cit.* p. 578.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London, *January 5th*, 1859.—The following communications were read :—

1. "On Fossil Plants from the Devonian Rocks of Gaspé, Canada." By Dr. J. W. Dawson, F.G.S., Principal of McGill's College, Montreal.

The plant-bearing rocks in the peninsula of Gaspé were first noticed by Sir W. E. Logan in 1843. To determine these fossil plants accurately, it was necessary to study them in place. With this view Dr. Dawson visited Gaspé last summer, and carefully examined the localities by the aid of the plans and sections of the Geological Survey of Canada. The strata referred to have a vertical thickness of 7,000 feet, as estimated by Sir W. Logan; they rest on Upper Silurian rocks, and underlie the Carboniferous conglomerates; and some beds contain Lower Devonian Brachiopods, &c.

Among the vegetable remains determined by Dr. Dawson is a curious genus, termed by him *Psilophyton*, which belonged to the *Lycopodiaceæ*, and had minute adpressed leaves on slender dichotomously-branching stems, with circinate vernation, and springing from a horizontal rhizome, which had circular areoles with cylindrical rootlets. Some of the shales are matted with these rhizomes. Obscure traces of fructification are observable in cuneate clusters of bracts. The fragments of the different parts of this interesting plant might easily be mistaken for portions of other and very distinct plants, such as *Karstenia*, *Halonia*, *Stigmaria*, *Schizopteris*, *Trichomanites*, Fucoids, &c. The author describes two species of *Psilophyton*, *P. princeps* and *P. robustius*.

Dr. Dawson further described a new form of *Lepidodendron* (*L. Gaspianum*); also some specimens of Coniferous wood related to the *Taxus* (*Prototaxites Logani*), and some less clear forms belonging to *Knorria*, *Poacites*, &c. The author also noticed the occurrence of *Entomostraca* (*Beyrichia*), *Spirorbis*, occasional fish-remains, some Brachiopods, and also rain-marks and ripple-marks in these Devonian beds.

[Specimens of the Fossil Plants from Gaspé were exhibited in illustration of this paper.]

2. "On some Points in Chemical Geology." By T. Sterry Hunt, Esq., of the Geological Commission of Canada. (Communicated by Prof. A. C. Ramsay, F.G.S.)

§ I. Referring to his communications to other Societies, in which he had endeavoured to explain the theory of the transformation of sedimentary deposits into crystalline rocks, and to the researches of Daubrée, Senarmont, and others, the author remarked, in the first place, that the problem of the generation, from the sands, clays, and earthy carbonates of sedimentary deposits, of the various siliceous minerals which make up the crystalline rocks, may be now regarded as solved; and that we find the agent of the process to be water, holding in solution alkaline carbonates and silicates, acting upon the heated strata. Under some circumstances, however—such as the presence of gypsum or magnesia—such anomalies might occur as are presented by the comparatively unaltered condition of some portions of the strata in metamorphic regions.

§ II. Many crystalline rocks, formerly regarded as of plutonic origin, are now found to be represented among altered sedimentary strata; and the chemical student in geology is now brought to the conclusion that metamorphic rocks, such as granite, diorite, dolomite, serpentine, and limestone, may, under certain conditions, appear as intrusive rocks. This is chiefly owing to the pasty or semi-fluid state which these rocks must have assumed at the time of their displacement.

§ III. The author next remarked that the promulgated hypotheses relating to the origin of the two great groups of plutonic rocks—those with potash and much silica, and those with soda and less silica—are not satisfactory.

§ IV. Mr. Hunt, considering that the water of the early palæozoic ocean differed from that of the modern seas, in that it contained chlorides of calcium and magnesium to a far greater extent, especially the former, sulphates being present only in small amount, noticed that the replacement of the chloride of calcium by common salt involved the intervention of carbonate of soda and the formation of carbonate of lime; and that the continual decomposition of alkaliferous silicates to form the vast masses of argillaceous sediments from the felspathic minerals of the earth's crust, must have formed, and is still forming, alkaline carbonates which play a most important part in the chemistry of the seas.

§ V. The study of the chemistry of mineral waters, in connexion with that of sedimentary rocks, leads the author to believe that the result of processes continually going on in nature is to divide the silico-argillaceous rocks into two great classes; the one characterized by an excess of silica, by the predominance of potash, and by the small amounts of lime, magnesia, and soda, and represented by the granites and trachytes; while in the other class silica and potash are less abundant, and soda, lime, and magnesia prevail, giving rise (by metamorphism) to triclinic felspars and pyroxenes. The metamorphism and displacement of sediments may thus, he observed, enable us to explain the origin of the different varieties of plutonic rocks, without calling to our aid the ejections of a central fire. (See § III.)

§ VI. The most ancient sediments, like those of modern times, were doubtless composed of sands, clays, and limestones; but, on the principles laid down in §§ IV. and V., the author shows that the chemical composition of the sediments in different geologic periods must have been gradually changing. Illustrating his views by the condition of the Canadian rocks, Mr. Hunt observes that, on the large scale, in the more recent crystalline or metamorphic rocks, we find a less extensive development of soda-felspar, while orthoclase and mica, chlorite and epidote, and silicates of alumina, like chiastolite, kyanite, and staurotide (which contain but little or no alkali, and are rare in the older rocks), become abundant. The decomposition, too, of the rocks is more slow now, because soda-silicates are less abundant, and because the proportion of carbonic acid in the air (an efficient agent in these changes) has been diminished by the formation of limestones and coal.

§ VII. The author accepts the views of Babbage and Herschel as to the internal heat of the earth rising through the stratified deposits, on account of the superficial accumulation of sediments, metamorphosing the rocks submitted to its action, causing earthquakes and volcanic irruptions by the evolution of gases and vapours from chemical reactions, and giving rise to disturbances of equilibrium over wide areas of elevation and subsidence.

§ VIII. Mr. Hunt observes that the structure of mountain-chains, both those due to the uprise of metamorphosed rocks through tertiary and secondary deposits, and those formed of older masses of sediment, contorted and altered, bears out the principles of § VII.

[A collection of the so-called "Kelpies' Feet," from the micaceous flagstones of North Britain, from the Museum of Practical Geology and the Society's Museum, were exhibited at this Meeting.]

January 19, 1859.—The following communications were read:—

1. "On the Gold-field of Ballaarat, Victoria." By H. Rosales, Esq. Communicated by W. W. Smyth, Esq., Sec. G. S.

Mr. Rosales described the position of the quartz-lodes (the matrix of the gold) in the schists of the hill-ranges, from whence originate the numerous auriferous gullies, forming eventually several channels (charriages), and the different courses of the old gold-bearing streams, which gradually passing to lower levels, reach the great areas of basalt, under which they continue their hidden course. To illustrate these points, the author prepared and sent a MS. map of the district from beyond Buninyong to Creswick, on which the granite, basalt, schists, and quartz lodes were shown, as well as the gold-channels, gullies, runs, leads, &c., connected with which 96 named spots or diggings were carefully indicated.

2. "Description of a New Species of Cephalaspis (*C. Asterolepis*) from the Old Red Sandstone of the neighbourhood of Ludlow." By John Harley, Esq., Subdean, &c., King's College. Communicated by Prof. Huxley, F.G.S.

This new form of *Cephalaspis* (from Hopton Gate) is at least twice the size of *C. Lyellii*, and is further characterized by the position, obliquity, and magnitude of the orbits. The space between the orbits is proportionally small, and the occipital crest very short. The outer enamel-layer is ornamented with tubercles, which, though somewhat variable, bear so close a resemblance to those covering the bony plates of *Asterolepis*, as to have suggested the specific name. The inner layer of the bony plate presents lacunæ and canaliculi resembling those of human bone; and many of them, in the specimen described, are naturally injected with a transparent blood-red material, so distinctly and delicately, that in their minutest details the structure of canals not more than $\frac{1}{50000}$th of an inch in diameter is beautifully revealed.

Mr. Harley also described a more perfect specimen of *Cephalaspis Salweyi* than the one on which Sir P. Egerton not long since determined the species. It was found by Mr. Salwey at Hinstone near Bromyard. Associated with the *C. Salweyi*, the author found a specimen of either a dermal plate or a tooth of a placoid fish, resembling some Silurian fossils called *Cœlolepidæ* by Pander.

GEOLOGISTS' ASSOCIATION.—On Tuesday, the 11th Jan. instant, the First Ordinary Meeting of this Association was held in the Library of St. Martin's Hall. There were nearly 200 persons present.

The proceedings commenced by the election of several new members, after which the President, Mr. Toulmin Smith, proceeded to deliver an inaugural address.

In opening the subject, the President directed special attention to the importance of finding true facts; he stated that it had been well observed that there are even more *false facts* than there are *false theories* in the world.

He remarked that Geology is a science which rests exclusively on a knowledge of the outer world, and can only exist as a science in the true interpretation of the facts which that world shows to us; that there is no science which has been, and is, liable to be more hindered by *false facts*. There is none, therefore, in which the gathering up of true facts, and the bringing them together as a common stock for the use of science, can be more needed. This being so, there appear to be good reasons for the work set to itself by the "Geologists' Association." Beyond the mere advancement of the common stock of knowledge by means of association, it was to be hoped that the enterprise of this country might be materially helped by its labours, and that it, in return, would receive its reward in being made the depository of many facts and observations, which, but for its existence, would remain buried in the note-book. And, further, that by giving right directions to those engaged in public and other extensive works, there would be good ground to hope that many facts tending to the verification of conclusions already drawn, and the settling of problems acknowledged to stand open, might be obtained; and, perhaps, even the opening-up of fields which as yet have been but little, if at all, worked.

Referring to some observations made by Mr. Salter, in a letter to the Editor of the GEOLOGIST, Mr. T. Smith said:—As to the collection of "*good facts*," we hope that at every meeting of the Association communications of observed facts will be made by members. The statement of these will appear in the printed minutes of our proceedings; and these, being circulated among all our members, will convey to every quarter some of those means of comparison and suggestions for research which are what the local Geologist most needs, both to encourage and to enlighten him.

Alluding to the success of the undertaking, it was stated that, within six weeks after the first conference on the subject, not less than 150 gentlemen, many of them well known in connexion with Geological Science, applied for membership.

And, with a view to the perfect understanding of various objects which the Association proposed to follow, and the advantages it held out to its members, the President entered at some considerable length into the plans which had been laid down for promoting and facilitating the collection and exchange of fossils; the formation of a collection of type-specimens which should serve, amongst other purposes, as a key to the larger national collections in this country, which from their extent and richness prove often a source of perplexity rather than of instruction to the humble student.

The formation of a collection of the character proposed is confessedly a matter of difficulty; it is far easier to accumulate specimens in large numbers, than to bring together only such as shall be really useful; but, observed Mr. Smith, be the difficulties to be encountered what they may, our hope is that we may be able by degrees to form a cabinet which shall be truly typical and always instructive. Whilst dwelling on this part of the subject, opportunity was taken to acknowledge the receipt of several promises of fossils illustrative of the principal formations.

A vigorous protest was entered against the undue use of hard words in scientific language, on the ground that we, as Englishmen, possess a language more copious than the Greek or Latin, and one which is peculiarly adaptable for the compounding of words, and which, therefore, may be most readily moulded to the expression of new forms of fact and thought.

This part of the address was followed by some very useful hints to collectors, and some interesting illustrations, to show the necessity of proceeding on sound principles and inductions before concluding upon mere appearances. The President urged the importance of always recognising the fundamental Law of Unity which underlies all the phenomena of nature, as being absolutely necessary to right conclusions, both as to single facts and broad generalization on collections of facts.

Mr. Smith concluded by urging the members to use their united efforts for the promotion of the common objects of the Association, being convinced that if the mutual principle on which it was based was fully acted upon, its value would soon be felt, and all would be satisfied that the Association had not been formed in vain.

After the Address was given, several fresh applications for membership were received.

The next Meeting will be held in the Library of St. Martin's Hall, on Tuesday evening, the 8th February, at 7 o'clock, when Dr. Hyde Clarke, and Mr. Rees, of Lucknow, have promised to read papers of great interest.

Thos Davids

bur
eng
th
set
eve

th
th
m
ou
to
wh
hir

aft
th

As
Pr
do
for
po
ex
to

of
br
th
by
W
le
fo

la
th
in
of

ar
p
u
u
co
of

p
m
sc
ir

re

e
L

THE GEOLOGIST.

MARCH, 1859.

PALÆONTOLOGICAL NOTES ON THE BRACHIOPODA.

By Thomas Davidson, Esq., F.R.S., F.G.S., etc.

No. 2. *On the Families* Strophomenidæ *and* Productidæ.

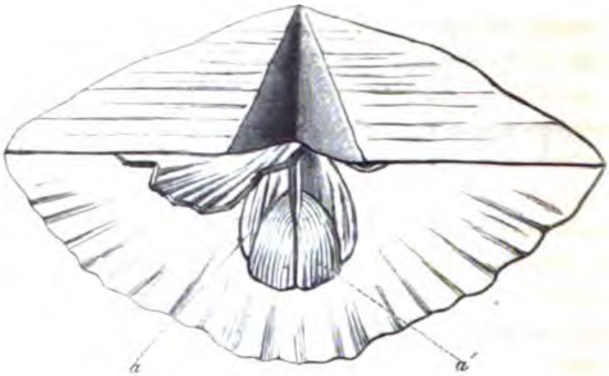
In my last communication, I endeavoured to lay before the reader all the more important facts, already acquired, relative to the genera and sub-genera that are provided with spiral appendages for the support of the oral arms;* and at the same time I referred to several points which still required to be elucidated and explained before the subject could be considered to have been satisfactorily studied.

In a note at the conclusion of that paper, allusion was made to a well-preserved internal cast of *Cyrtina septosa*, of which I now offer a representation, as it will show that the muscular impressions in the smaller or dorsal valve are similarly arranged to those of *Spirifera*, and that there does not exist in that valve any septa, as in *Pentamerus;* the resemblance to the last-named genus being merely in the disposition of the median septum, and of the converging dental or rostral plates of the larger or ventral valve.

I may likewise mention, before commencing the subject of the present communication, that, although the muscular impressions in the larger or ventral valve of *Athyris* or *Spirigera* are generally well

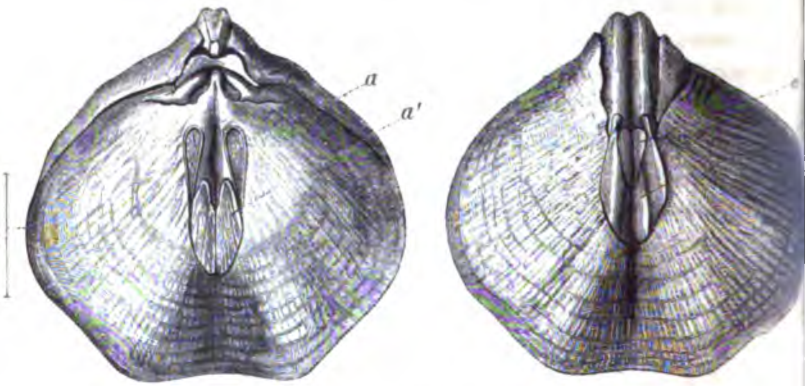
---

* The Geologist, vol. i. p. 409. 1858. This paper has been translated into French by my friend Professor L. de Koninck, and will be published in the Transactions of the Royal Society of Liège, for 1859.



Lign. 1.—Cast of Dorsal Valve of *Cyrtina septosa.*

a Adductor, or posterior occlusor.
a' Adductor, or anterior occlusor.



Lign. 2.—Magnified Views of Casts of *Athyris ambigua.*

Fig. 1. Internal cast of the *dorsal* valve.
a Adductor, or posterior occlusor.*
a' Adductor, or anterior occlusor.

Fig. 2. Internal cast of *ventral* valve.
a Adductor, or occlusor.
r Cardinal, or divaricator.

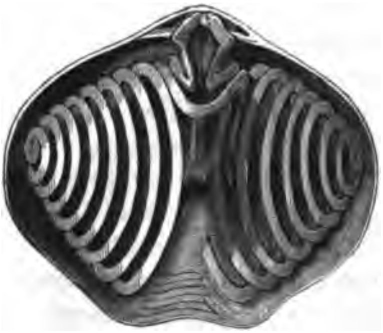
---

* In order to avoid further repetitions, I may mention once more that the muscles the function of which is to open or separate the valves have recently been termed *divaricators* and *accessory divaricators* by Mr. Hancock; and those the function of which is to act in the closing of the valves have been termed *anterior* and *posterior occlusors* by the same distinguished zoologist. The *divaricators* are those usually termed "cardinal muscles" ("adductor brevis" of Owen; "muscles

seen, and have been correctly represented and explained, those on the interior surface of the smaller or dorsal valve are rarely discernible. The scars left by the adductor, or anterior occlusor, muscle were defined by Bouchard in *Athyris concentrica*; but the impressions of the posterior pair could not be distinguished upon any of the numerous valves in his possession; although it is most probable, not to make use of the word "certain," that in this, as well as all other species of the genus, the adductor or occlusor had a quadruple attachment to the ventral valve.

Dr. Sandberger has represented the muscular impressions of both valves of *Athyris* or *Spirigera undata*; but not in quite so precise a manner as could be desired, or as is really seen on some silicified internal casts of *A. ambigua* from the carboniferous limestones of Bakewell (Derbyshire), in the Museum of Practical Geology, and of which two enlarged illustrations are here appended (Lign. 2, figs. 1 and 2).

I have also ascertained that the spiral processes, and their intermediate connecting lamellæ are in *Athyris ambigua* similarly disposed to those of *A. pectinifera*, of which we have already given an illustration in our previous paper, so that there can exist scarcely any doubt that the same arrangement was common to all the species of the genus.



Lign. 3.—Interior of the Dorsal Valve of *Athyris ambigua*. Restored from specimens in the Museum of Practical Geology.

Mindful of the popular character of THE GEOLOGIST, it will be

diducteurs" of Gratiolet); while the *accessory divaricators* are better known by the name of "accessory cardinals" or "cardinalis" of Owen.

The *occlusor* is the "adductor" of the generality of authors; the *anterior occlusor* being the "adductor longus anticus" of Owen; the *posterior occlusor*, the "adductor longus posticus" of the same distinguished anatomist.

The pedicle-muscles have been termed *adjustors* by Mr. Hancock, under the belief that they move the shell upon its peduncle, and adjust it; while the "capsularis" of Owen, is Hancock's *peduncular muscle*.

my endeavour to make this article as explicit and intelligible as the subject will permit; for in palæontology it is not always possible to avoid having recourse to certain technicalities when one is desirous of conveying precise information upon special subjects. The reader will, however, experience but little difficulty, if he will cast his eye over the accompanying figures, which have been drawn with all possible accuracy, so as to make up for any deficiencies that may exist in the descriptions.

The families STROPHOMENIDÆ (*Orthidæ* of some authors) and PRODUCTIDÆ have been the subject of long and patient research; and, although much progress has been made towards their elucidation, I am not yet entirely satisfied that the differential characters specified by authors are in every case of sufficient importance or value to warrant the many divisions at present provisionally established.

Every geologist and the generality of collectors are acquainted with the external shape of some species of *Orthis*, *Strophomenæ*, and *Productæ*; but since the days of Dalman, Rafinesque, and James Sowerby, these old genera have been much subdivided, and others have been discovered, which, by presenting certain intermediate characters, have proved the natural connexion which exists between the two families. It cannot be expected that palæontologists, however diligent and learned, should be able all at once to arrive at a just and satisfactory appreciation of the value of certain groups of extinct animals; but what does more injury to science, and retards its progress, is the precipitation with which new genera are sometimes proposed;* and it should always be remembered that, although it is necessary and right to separate what is dissimilar, one cannot be too careful and cautious, while determining whether the differences observed are constant and of more than specific importance.

---

* In the last page of the German edition of my "General Introduction" (Vienna, 1856), Professor Suess has appended a list of no less than 160 generic names, under which the known species of Brachiopoda had been located up to the year 1856! And since that period, several others have been proposed by Messrs. Hall, Suess, and Billings. In the French edition of the same work, I provisionally admitted 24 genera and 22 sub-genera, making a total of 46; but of these, a few were mentioned with doubt; and, although I believe we are working in the right path, much care must be exercised not to exaggerate the number of genera and sub-genera, and thus to be causing confusion where simplicity should prevail.

The following are the genera into which the families under description have been provisionally divided*.:—

Family.	Genera or Sub-genera, Author, Date, and a Typical Species.	Geological Range.					
		Silurian.	Devonian.	Carboniferous.	Permian.	Triassic.	Jurassic.
STROPHOMENIDÆ	PORAMBONITES. Pander. 1830. *P. æquirostris.*	×	.	.	.	.	.
	ORTHIS. Dalman. 1827. *O. rustica.*	×	×	×	.	?	.
	ORTHESINA. D'Orb. 1849. *O. anomala.*	×	.	.	.	.	.
	STREPTORHYNCHUS. King. 1850 *S. pelargonatus.*	?	×	×	×	.	.
	STROPHOMENA. Rafinesque. 1820 *S. planumbona.*	×	×	×	.	.	.
	LEPTÆNA. Dalman. 1827. *S. transversalis.*	×	×	×	?	×	×
	TROPIDOLEPTUS. Hall. 1857. *T. carinatus.*	.	×	.	.	.	.
	STROPHODONTA. Hall. 1852. *S. depressa.*	.	×	.	.	.	.
PRODUCTIDÆ	CHONETES. Fischer. 1837. *C. sarcinulata*, or *C. Prattii.*	×	×	×	×	.	.
	STROPHALOSIA. King. 1844. *S. Goldfussii.*	.	×	×	×	.	.
	AULOSTEGES. Helmersen. 1847. *A. Wangenheimi.*	.	.	.	×	.	.
	PRODUCTA. Sowerby. 1814. *P. gigantea.*	?	×	×	×	.	.

The generality of palæontologists of the present day appear to be agreed as to the propriety of forming two families out of the genera or sub-genera above enumerated; but I am beginning to fear that the characters by which some are distinguished will turn out to be of less importance than was at one time imagined.

It has been stated that external spines were peculiar to the *Pro-*

---

* Family names are derived from those in the typical genera; and, as in the present instance *Strophomena* and *Productus* were established first, it behoves us to admit them in preference to others subsequently introduced. Naturalists have not hitherto agreed as to what should constitute a genus or sub-genus; and as some even entirely object to the term "sub-genus," I have not made any such distinctions in the table here given; but I have endeavoured to arrange the names according to their more probable affinities. When treating of the *Strophomenidæ*, we will endeavour carefully to compare the different "genera" or "sub-genera" with each other; as the differential characters do not appear to me to have been in all cases satisfactorily established.

ductidæ, and were always absent in the *Strophomenidæ;* but it is now well known that the presence or absence of spines cannot be considered a character of importance, since in many families among the Mollusca we find genera and species both with, as well as without those appendages.

About a year or two ago, Prof. L. de Koninck lent me a British specimen of *Orthis*, like the one which he had represented in Pl. XIII. fig. 8, of his work on Belgian Carboniferous Fossils, as an example of *Orthis Michelini;* but, as the specimen in question was thickly covered with short spines, similar to those that cover the valves of *Producta punctata*, he subsequently felt uncertain whether it could be referred to the first-named species, which he did not believe to have been provided with those appendages. Since that period I have obtained several examples of the *O. Michelini* which evidently possessed numerous scattered spines over their external surface; thus proving the correctness of the Professor's original determination.*

The only general feature of any importance that can be brought forward in the separation of the two families is that of the so-termed *reniform impressions*, which are present, although not always clearly distinguishable, in the interior of the smaller or dorsal valve of all the species of *Productidæ* hitherto discovered, but of which no trace has been seen in any of the *Strophomenidæ* at present known.

The PRODUCTIDÆ have been divided into four genera, or sub-genera, viz. *Producta, Aulosteges, Strophalosia*, and *Chonetes;* but, as they all bear so natural, and, indeed, so intimate a relation towards each other, we will mention the characters of the group, and at the same time specify those details by which each in particular has been distinguished. I should likewise wish to observe, that a prolonged study of the family has disposed me to believe *Aulosteges, Strophalosia*, and *Chonetes* to be simple sub-genera, or modifications, of *Productus;* and this is also the opinion of Prof. de Koninck.

* It is likewise certain that some examples of *Orthis resupinata* and *O. Keyserlingiana* were furnished with small scattered spines. Probably such spines have escaped observation, not merely from their being of a very delicate nature, and consequently liable to abrasion and injury before being buried up in the ancient mud, but oftener, possibly, through the hardness of the limestone-matrix which adheres to the outer surface, causing the latter usually to flake off in breaking out the specimens, and which remains in the mould undetached from the embedded spines. For the opposite reason, probably, it is that specimens from shales are generally more perfect than those from limestones.

All the species at present known are restricted to the limits of a portion of the Palæozoic Period; but experience has taught us that any day may bring forth the discovery of some form in a higher or lower stage; thus, until 1847, the *Strophomenidæ* were considered to be limited to the Palæozoic Era, when two or three species of *Leptæna* were unexpectedly discovered in the secondary or Mesozoic strata; and this first discovery led to that of a large number of species in the same and other localities.

As no living representatives of the families exist, the character of those portions of the animal can alone be deciphered and described which have left their impressions upon the interior surface of the shell; hence the necessity of carefully seeking for these marks with great attention, and of comparing them with those observable upon the internal surfaces of species of other families which have been anatomically investigated. Thus, by analogy, we are gradually led, step by step, to reconstruct in our minds the animal which has for countless ages ceased to be represented in the successive series of creations.

In this paper we shall treat of the PRODUCTIDÆ, and we commence with the external characters. The species are very numerous, and among them may be seen some of the largest Brachiopoda at present known. The shell is concavo-convex, regular or irregular in its growth; transverse or elongated, more often oval, semi-oval, or angular, and generally auriculate. The hinge-line is long and straight, with or without teeth and sockets for the articulation of the valves. All well-authenticated species of *Producta* and *Aulosteges* hitherto examined have shown themselves to be edentulous; but whether such character was general to all the species, or only peculiar to a certain number, will require further confirmation.* Anyhow (as has been justly observed by Mr. S. P. Woodward, in his excellent Manual on the Mollusca), the dorsal valve must have turned on its long hinge-line with as much precision in the edentulous species as in those of *Chonetes* and *Strophalosia*, which were regularly articulated by teeth. It must not, however, be inferred, from the statement here recorded, that the animal ever separated, or required to separate, its valves as widely as could be effected by moving the lid of a snuff-box upon its hinge; on the contrary, it is probable that the valves were never separated by the animal to the extent of more, at the utmost, than a few lines, as was also the case with the other articulated genera with which we are at present acquainted.

---

* In the tenth volume of the Quarterly Journal of the Geological Society (p. 202, pl. VIII. 1853), I described and figured as *Chonetes comoides* several remarkable exteriors and interiors, which, I believe, along with Messrs. Salter, Woodward, and King, to be referable to a single species (Pl. IV. fig. 7). The sharply defined and well-developed area in each valve, the fissure in the ventral one, and the produced cardinal process in the other, as well as the strongly articulated hinge, have up to the present time been considered characters peculiar to *Chonetes*, and not to *Producta*, especially since all well-authenticated species and specimens (hitherto examined) of the last-named genus have proved to be edentulous. Small pits, observable at intervals along the cardinal edge in several examples which I then or have subsequently examined, seemed also to denote the existence of small cardinal spines, similar to those observable in certain species of *Chonetes*; nor do the muscular impressions in the interior of the ventral valve (unfortunately only one specimen is at present known) militate against such a

It has also been stated, and generally believed, that *Producta* might be distinguished from its sub-genera by the total absence of an area in either valve; but, although this would appear correct in the generality of species, some exceptional specimens have exhibited a distinct and defined area in the ventral valve.* In all species of *Strophalosia*, *Chonetes*, and *Aulosteges*, at present known, a triangular or sub-parallel area, of variable dimensions, has been recognized; and this is larger in the ventral than in the dorsal valve, in which it is moreover divided by a fissure, more or less arched over by a pseudo-deltidium; the cardinal process of the opposite valve filling up and effectually closing any portion that might otherwise have remained uncovered.

---

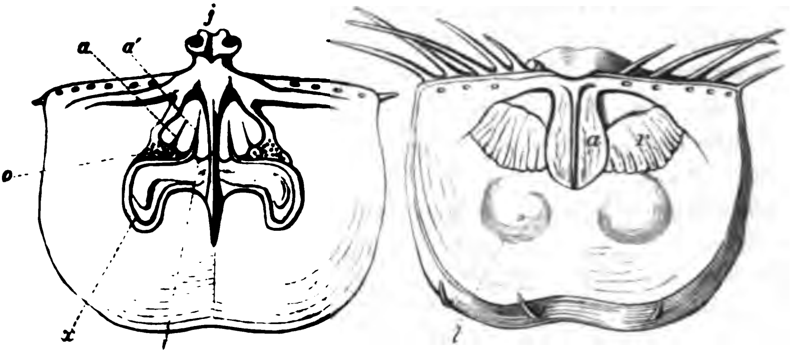
conclusion. If, therefore, the shells in question belong to *Producta*, and not to *Chonetes* (as Professor de Koninck appears disposed to believe), the genus or sub-genus *Chonetes* would become superfluous, and our notions regarding *Producta* require material alteration, since the genus would be made to contain both edentulous as well as strongly articulated species. Such a supposition would demand much further examination and confirmation before being admitted as a definitely settled fact. At the time the paper above referred to was communicated, Mr. D. Sharpe announced that in his opinion fig. 1 alone belonged to *Chonetes comoides*, and that fig. 2, &c. were referable to another, although closely allied, species. Since that period Professor de Koninck has referred them to *Producta hemisphærica*, Sow. There again I must be allowed to observe that none of Sowerby's original specimens of the last-named species show any area, nor apparently any articulated hinge; they bear, however, so exact a resemblance to a true *Producta* that it would be necessary to examine a larger number of specimens before I possibly could conscientiously admit the identification to be strictly correct. I am happy, however, to know that my distinguished friend, who has devoted so much time to the study of the species of which this family is composed, intends shortly to issue a supplement to his great work, in which he will fully express his views regarding the subject of the present note.

* A very remarkable specimen of *Producta semireticulata*, which at one time formed part of Mr. Charlesworth's collection, illustrating this feature, has been recently added to the British Museum. This also presents a small pseudo-deltidium.

The external surface varies according to the species. In some it is almost smooth; in others it was longitudinally and finely striated, or coarsely costated, as well as intersected by numerous concentric wrinkles, or lines of growth. All the specimens appear to have been furnished, more or less, with tubular spines. In some *Producta*, *Strophalosia*, and *Aulosteges*, both valves were so ornamented; while in others they were restricted to the ventral valve. In certain species they are small, delicate, and so closely packed as to conceal every portion of the shell, with the exception of the area; while in others they were irregularly scattered, and chiefly confined to the auriculate portions of the valves. In certain species the spines exceeded by four or five times the length of the shell; and while some were almost as delicate as the hair of one's head, others exceeded a line in diameter; the dimensions of the shell, however, had nothing to do with that of the spines; for in some small species these were few and large, while the reverse has occasionally been found to be the case with species of the largest dimensions. *Chonetes* alone appears to have differed from *Producta*, *Aulosteges*, and *Strophalosia*, in its tubular spines, which are in all known species confined to the cardinal edge of the ventral valve, where they are regularly disposed and interspersed, generally increasing in length as they approach the extremities of the shell. The intimate structure of the shell has been described by Dr. Carpenter, in the second chapter of the "General Introduction" to my work on British Fossil Brachiopoda, and from which I will extract the following passage:—"In all the genera of this family large perforations exist, resembling those of *Strophomena depressa* in their general aspect, and in the infundibular arrangement of the laminæ of the shell around them. Where the shell is furnished with spines, as is especially the case with *Producta horrida*, the perforations are continued into them; and such passages are of more than the average dimensions."

These are the more important external features presented by the family. We will now examine the *interior dispositions*, and will commence with those which relate to the smaller or *dorsal* valve.

In the *Productidæ* the internal surface of this valve is more or less convex, and presents in the middle of the hinge-line a prominent bi-lobed or tri-lobed projection, which has been termed a "cardinal process;"(*j*)* its upper surface is often striated, and afforded attachment to the cardinal or divaricator muscles (*r*). Under this a narrow longitudinal ridge generally extends to about half (or more) of the length of the valve, and on either side are seen the ramified or dendritic impressions which we consider to be attributable to the adductor, or posterior (*a*) and anterior (*a'*) occlusor muscles.



Lign. 4.—*Producta horrida.*

Fig 1. Interior of Dorsal Valve.
a. Posterior occlusor. a'. Anterior occlusor.
w. Oral prominences (Woodward).
x. Reniform impressions (King).
j. Cardinal process.

Fig. 2. Interior of Ventral Valve.
a. Occlusor.
r. Divaricator.
l. Hollows occupied by the spiral arms.

In *Producta* and in *Aulosteges* the posterior and anterior divisions of the occlusor muscles (*a a'*) are at times situated so close to each other, on either side of the mesial ridge, as to render the quadruple attachment not so distinct as could be desired; but they are well defined in *P. horrida*, *P. longispina*, &c.

Outside and in front of the muscular scars above described, are the two "reniform impressions" before referred to (*x*). Their surface is generally smooth; they are bounded by ridges, which, after dividing the occlusor muscles, proceed in an outward oblique or almost horizontal direction; then, turning abrubtly backwards, they terminate at a short distance from their origin. There exists also in many species, but not in all, two prominences (*w*), one on each side of the median ridge, and close to the base of the muscular scars. These are very apparent in *Producta* and *Aulosteges*, but are not observable either in *Strophalosia* or *Chonetes*.

---

* In the plates accompanying this article the same letters are used for the corresponding parts as are inserted in the woodcuts.

The internal surface of the valves in all the family is covered with innumerable granulations, some of which are thought by Mr. Hancock to have been "probably produced by the muscular bands which retracted the margin of the mantle."

We will now describe the internal appearances observable on the concave surface of the larger or ventral valve. A narrow mesial ridge, originating under the extremity of the beak, separates the two large elongated, ramified, or dendritic impressions which have been referred by Mr. Woodward and myself to the adductor or occlusor muscles; and in this opinion we have Mr. Hancock's concurrence, for it is the position occupied by the same muscle in all the articulated genera of Brachiopoda with which we are at present acquainted. This view is, however, dissented from by the distinguished Russian palæontologist and geologist, Count Alex. Von Keyserling, as well as by some others who consider these impressions attributable to ovarian sinuses, and who would go the length of supposing that *Producta* did not require adductor or occlusor muscles; but the largely developed cardinal process seems to denote that there must have been divaricator or cardinal muscles, and in all probability powerful ones; then, why should we not conclude that *Producta*, like their congeners, had also occlusor muscles. Count Keyserling doubts, likewise, the possibility of muscular fibres even producing dendritic impressions, but in the *Pectinidæ* (*e.g.* *Spondylus*), as well as in the *Unionidæ*, dendritic and granular muscular scars are not uncommon; and I am informed by Mr. Hancock that in *Anomia patelliformis* there is one with radiating lines. Professor King refers the large scars above described to cardinal or divaricator muscles, so that there exists a difference of opinion relative to the origin of the large dendritic impressions in *Producta*, which occupy a considerable portion of the umbonal cavity.

In *Chonetes* these impressions are similar in position, but of smaller proportions.

In advance of the large scars we sometimes (in *Producta*) perceive smaller impressions closely connected with the larger ones above-described (Pl. III. and IV. *c*). Professor King—and I believe correctly

—regards these as being due to the occlusor (his "valvular") muscles; for it is highly probable that these smaller scars in advance of the larger ones were produced by a portion of the occlusors themselves.*

Immediately under, but outside of, these there exists two deep, longitudinally striated, subquadrate impressions, which are in all probability due to divaricator (= cardinal) muscles, but which have been referred by Professor King to pedicle muscles.† In vain hitherto have I sought for impressions referable to adjustor muscles; but, as no peduncle existed in the *Productidæ*, such muscle might be supposed not to have existed; however, as the valves of some of these forms possess no teeth nor sockets, and, therefore, are not strongly articulated, as in the *Terebratulidæ*, it is not impossible that the adjustors may have been so arranged in *Producta* and *Aulosteges* as to keep the valves adjusted to each other, and that they have thus acted as a substitute for a hinge, somewhat in the manner Mr. Hancock has supposed to be the case in *Lingula*.‡

---

* Mr. Hancock informs me that the occlusors are undoubtedly formed of two elements, the anterior and posterior, and that we should not therefore be surprised to find indications of the two component parts in the ventral as well as in the dorsal valve. In *Lingula* the anterior and posterior occlusors are distinct, having four points of attachment in each valve.

† Prof. King has figured in his monograph of English Permian Fossils (Pl. XIX. fig. 2) what he terms vascular markings in connexion with these large muscular scars, and which seem to form part of the impression. Mr. Hancock appears disposed to consider the whole to be the scar of one muscle, and that there is nothing extraordinary in this, as it frequently happens that the same thing may be seen in the *Unionidæ* and other Conchifera.

‡ Although the case in question may not apply directly to *Producta*, it will be as well to mention that Mr. Hancock has found in *Lingula* three pairs of *adjustors*, apparently for the purpose of keeping the valves opposed to each other and of holding them adjusted. In this respect, they appear well calculated to compensate for the entire absence of hinge or teeth. He explains this in the following words: —"The external or ventral pair having their anterior extremities attached to the ventral valve—which, as it is fixed to the peduncle, is that from which all muscles act—and their posterior ends to the dorsal, it is evident that they will prevent the latter from being forced backwards; while the posterior adjustors having their terminations united to the ventral or fixed valve, and their anterior portion to the dorsal, they will act in the contrary direction, and guard against the pressure forward; they will also at the same time prevent any lateral displacement of the valves, as their diagonal position will enable them to act transversely, as well as longitudinally. The external and central adjustors will, on account of their oblique arrangement, exert a similar double influence in front." See Mr. Hancock's admirable memoir on the anatomy of the Brachiopoda, published in the "Transactions of the Royal Society" for 1858.

Mr. Howse remarks, in his paper, published in the Annals of Natural History (1857), that, when the cardinal process of *Producta* is *in situ*, it fills nearly the whole of the umbonal cavity of the ventral valve, and may thus assist in keeping the valves in position. It is possible, however, that future researches by the aid of better preserved specimens, may enable us to discover some traces of *adjustor* muscles.

The only point remaining to be mentioned in connexion with this valve, are the deep concave, often distinctly subspiral, depressions visible in some species of *Producta*, such as *P. gigantea*, and which have been referred to labial appendages by the generality of authors. They have been described by Mr. S. P. Woodward and myself as hollows probably occupied by the spiral arms; for, if not, it would seem impossible to conjecture how they originated. Similar hollows could not, of course, be expected to be present in those species in which the shell did not possess a sufficient thickness, as they never influenced the regular curve or convexity of the exterior of the valve. In all the *Productidæ* we therefore find the muscles destined to open and close the valve complete.

One of the most important features in connexion with Brachiopoda, and which has been made use of as a character in distinguishing them from other Mollusca, is the presence of those beautifully fringed appendages developed on either side of the mouth, to which the designation of "oral arms," or "brachial appendages," has been given by the greater number of naturalists.*

In the *Terebratulidæ*, *Spiriferidæ*, and *Rhynchonellidæ*, as well as in that singular group to which the term *Davidsonidæ* has been provisionally applied, the oral arms are known to have been more or less supported by variously disposed and differently shaped testaceous appendages; or, in other words, that the study of the animal of the existing species, composing the first and third families, has thrown much light upon the probable function as well as the manner in which these soft parts were attached and disposed. In the *Strophomenidæ* and *Productidæ* no such calcified supports have been hitherto detected; and therefore we cannot speak with the same confidence as to the dispositions which these parts assumed in the two last-named families. Every discovery that can throw some light upon the subject is of importance to the zoologist as well as to the palæontologist, and should therefore be sought after with the greatest attention.

---

* In his Memoir, Mr. Hancock has stated that the brachial appendages subserve at once the function of gills and of sustentation. To prove that they are aerating organs, "it is only necessary to refer to the manner in which the blood circles round the arms, and is carried to the cirri, but more particularly to its circulating through these latter organs, and to its return direct from them to the heart."

Since the Brachiopoda have become the object of scientific and conscientious study, it has always been believed that the *Productidæ* and *Strophomenidæ* were provided with oral arms, although little positive evidence as to their presence has been more often left in the interior of the valves. In many species of *Strophomenidæ* and *Productidæ* the space left for the animal between the valves is so exceedingly small that one can hardly conceive how all the parts could have been lodged or disposed; still they did exist, and, no doubt, fulfilled the same functions, and were as perfectly organized as in those species which possessed a more spacious dwelling; just as one of those very thin Geneva watches of modern times is as perfect in its parts and action, as were the far more bulky time-pieces manufactured by our ancestors.

In all the species of existing articulated genera in which the animal has been examined, the oral arms were attached or supported by calcareous processes in connexion with the dorsal valves, so that it behoves us to seek for any probable attachment in that valve also among the *Productidæ* and *Strophomenidæ*. Mr. S. P. Woodward, who has devoted much attention, in conjunction with myself, to the internal character of the *Productidæ*, has supposed that the arms were perhaps attached to those two testaceous prominences (Pl. III. fig. 2, *w*, and Pl. IV. fig. 5, *w*), which are visible in some species of *Producta* and *Aulosteges*, a little lower down than the occlusor muscular impressions. These prominences may possibly have given support to the mouth somewhat in the manner of the crural processes of other species, and thus they may be said to have sustained also the bases of the arms. This suggestion, however, cannot be demonstrated by the direct examination or comparison of the animals of existing species of other families. These prominences are not present in *Strophalosia* or *Chonetes*, and therefore are not common to the group.

In the Museum of Practical Geology I found a very remarkable specimen of *Producta gigantea*, which, although imperfect at the margin and cardinal process, possessed all the important parts relating to the interior of both valves as perfectly preserved as could be desired. From this, the two large representations accompanying this paper (Pl. III. figs. 1 and 2) have been carefully drawn. It will be observed that in the interior of the dorsal valve there exist two much larger conical projections (z), situated immediately under the eminences (*w*), termed "oral processes" by Mr. Woodward, and these (z) I have found to correspond almost exactly with the centre of the subspiral hollows in the ventral valve (*l*). It is therefore highly probable that at least a portion of the arm was spirally coiled, and occupied the space existing between and all round the conical testaceous projections (z) described above, as occurring in the dorsal valve, and the hollow (*l*) in the ventral one,* in the same manner as we have shown to have been the case with *Davidsonia*,† but with this difference, that in *Producta* there exists a conical elevation in the dorsal valve, and a corresponding hollow in the ventral one; while the very reverse was the case in *Davidsonia* and *Strophomena depressa* or *rhomboidalis* of Dalman (Pl. IV. fig. 13, L). From this I would surmise that the arms in the *Productidæ* were differently disposed to those in the *Davidsonidæ*, and at least some of the *Strophomenidæ*; that is to say, the whole or a portion of the arm formed a few vertical convolutions directed towards the bottom of the dorsal valve in *Davidsonia* and *Strophomena depressa*, while in *Producta* they were, on the contrary, directed towards the bottom of the hollows of the ventral one. I also consider that those deep conical hollows observable in the interior of the enormously thickened ventral valve of *Producta humerosa*, Sow., as seen in relief upon the internal cast (Pl. IV. figs. 3, L), to have been occupied by the arms. Such is the only reliable evidence that can be offered at present as to the form and position of the arms; but it is necessary here to mention that in his excellent work on the Petschoraland (published in 1846), Count Alex. von Keyserling has expressed an opinion that the so-termed uniform impressions or callosities (Pl. III. fig. 2, and Pl. IV. figs. 5, 7, 12, *x*) observable in the dorsal valve of all the *Productidæ*, were the probable supports of the oral arms; which view was at a later period reproduced by Mr. Howse, who, moreover, assimilates those impressions to the ridges supporting the arms in the interior of *Argiope* and *Thecidium*. Mr. Hancock is disposed to accept this interpretation of the origin of the reniform impressions, as he does not see how they can have anything to do with the vascular system, properly so called, and to which they have been attributed by various authors. They could not possibly have been produced by pallial or ovarian sinuses; for, if so, we should have expected to find them also in the ventral valves.*

---

* In a letter I had the pleasure of receiving from Count Keyserling, it is stated, that, "if in the ventral valve of *Producta gigantea*, and some few others, we see the indication of obscure spiral depressions, this may be due to the unattached portion of the arms; but that we perceive no similar hollows in the same valve of the greater number of species;" but it should also be remembered that we cannot expect to find hollows in those forms in which the valve was too thin to admit of similar depressions.

† THE GEOLOGIST, Vol. I., Pl. XII. figs. 33, 34.

We will now add a few words relative to the probable mode of existence assumed by the *Productidæ*, and which does not appear to have been the same for all the species of which the family is composed. The opinion entertained by some palæontologists that the shell was suspended by muscular fibres issuing from tubular cardinal spines, or from between the margins of the shell, are highly improbable, and unsupported by any acceptable evidence. It is, however, probable that some of the species were free and unattached, while others show clear evidence as to their having adhered to marine bodies by the beak of their ventral valve (*e. g. Strophalosia* and *Aulosteges*). D'Orbigny supposes that the animal of *Producta* lived on soft sea-bottoms, lying with the smaller or dorsal valve uppermost, in a similar manner to oysters, scallops, and *Spondylus striatus*, the lamellæ and spines serving to retain the animal in a fixed position; but Professor Koninck objects, that these spines are often so long and so delicate as to make one believe that they would be fractured under such conditions. In a paper communicated in 1853 to the Geological Society, I endeavoured to show that the ventral valve in *Chonetes comoides*, *Producta hemisphærica*, *P. gigantea*, &c. is from four to eight times thicker, especially near the middle, than the dorsal one, which is, on the contrary, thin and light; and thus if the animal had lived with its larger and ponderous valve uppermost, no muscular power which it could have exercised would have been, in all probability, sufficient to raise the ventral valve; while, on the contrary, supposing the shell to have rested on its larger or ventral valve, the slightest force would suffice to raise and separate the smaller or dorsal valve.

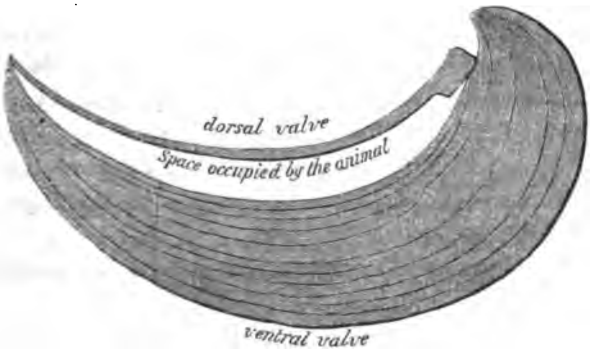
---

* In a letter I have recently received from Mr. Hancock, there is the following passage:—"The idea that the reniform impressions gave support to the arms does not appear inconsistent with the opinion expressed by you and others, namely, that a portion of each arm was arranged spirally, and occupied the hollows in the ventral valve. I am quite inclined to believe that these reniform callosities gave support to the first or basal portion of the arms. The arms may afterwards have become free, and have formed more or less incomplete spirals, and may have fitted into the subspiral cavities of the ventral valve in *Producta gigantea*, &c. In some other species no spirals may have been developed, and the extremities of the arms may have been disposed in some other manner. In *Thecidium* the terminal portions are variously arranged; and this may have been the case in the *Productidæ*. It is impossible not to be struck with the resemblance of the reniform impressions in fig. *a* of your Pl. IV., to the ridges supporting the arms of *Thecidium* in Pl. VI. fig. 42, of your General Introduction."

Professor King explains his views regarding the origin of the reniform impressions in the following words, which I think it well to reproduce in this place, that the reader may have before him the reasons adduced by those who would connect the above-mentioned impressions with the vascular system, as well as of those who attribute them to the ridges supporting the arms:—

"Taking *Leptæna analoga* and *Productus horridus*, as examples illustrating the characterism of the vascular system of their respective families, it may be predicated of *Strophomenidæ*, that the primary pallial vessels are more or less confined to the medio-longitudinal region of the valves; and of *Productidæ*, that they strike off at the moment they issue from between the muscular scars, in a lateral direction, running for some distance nearly parallel to the cardinal line, then curving forward and round towards the centre, and finally returning to nearly their origin. Looking at the vein-like line bounding the reniform lobes of *Productus horridus* [see the woodcuts] and *P. semireticulatus*, I cannot but think that these structures are each due to a recurving vessel, rather than to an expanded and simply projecting vascular organ, as appears to be the case in *Criopus* (*Crania*)."

Some singular forms of *Producta*, such as *P. proboscidea*, *P. genuina*, &c. have their ventral valves prolonged for more than two inches beyond the dorsal, the edges being rolled together in the shape of one or two tubes (Pl. 4, figs. 1 and 2). This circumstance has led d'Orbigny to explain this singular appearance, by supposing that the animal, from having lived in cavities, or half buried in mud, was obliged to prolong the edge of its mantle, and consequently also of its shell, so as to reach the surface of the sea-bed for maintaining the brachial currents. Mr. S. P. Woodward suggests that the shell of some species may perhaps have been attached by a peduncle when



Lign. 5.—Longitudinal Section of *Chonetes comoides*.

young; but this of course must remain, for the present at least, one of those uncertainties with which the science of Palæontology abounds; and I can quite concur with Mr. Toulmin Smith as to the necessity of carefully considering what we give out as *facts;* for indeed the word "certain" has been more often made use of where that of "probable" would have been more properly written.

In conclusion, whether it be desirable to retain some or all of the denominations or subdivisions in the Productidæ, no doubt can exist as to their intimate relationship.

Producta is supposed to have been always deprived of hinge-teeth and sockets for the articulation of the valves; and although this is the condition in all species hitherto examined, there may possibly have existed some exceptions. No distinct area is visible in the generality of species, but in certain specimens it is known to exist. *Aulosteges* has been considered by some as a synonym of *Strophalosia*, but the want of hinge-teeth and the great similarity of its interior details with those of *Producta*, makes me consider it even more closely connected with the last-named genus than with that of Professor King; or, in other words, that it is the connecting link between them.

Strophalosia and *Chonetes* are distinguishable from *Producta* by the invariable presence of hinge-teeth and sockets, as also by a distinct area in either valve, and by other minor interior details. *Strophalosia* was fixed by a portion of its larger valve, while *Chonetes* was probably free, and is in general recognizable by the position and disposition of its cardinal spines.*

In Notes No. 3 we will endeavour to describe and illustrate the character of the *Strophomenidæ.*

---

* Those who may feel desirous for more ample information concerning the Productidæ, will do well to consult Prof. de Koninck's excellent "Monographie des Genres Productus et Chonetes, Liège, 1847;" also the second volume of the "Geology of Russia, in Europe and the Ural" (1845); Count Keyserling's "Petschoraland" (1846); King's "Monograph of the Permian Fossils of England" (1850); Sowerby's "Mineral Conchology;" Woodward's "Manual of the Mollusca," and various other works and papers by MM. de Verneuil, Geinitz, Kutorga, Martin, and Howse, as well as the three editions of my "General Introduction," &c. In my "Monograph of British Permian Brachiopoda," published in 1858, the subject has also been attentively re-examined; and it may not here perhaps be considered out of place for me to remark, that during the careful preparation of that work, which occupied the greater portion of my time during one year and a half, I did my very utmost to be just and fair towards all concerned, allowing no bias or preference to interfere with my judgment; and although I may be mistaken with respect to certain scientific questions, I have not hitherto perceived any valid grounds for altering the conclusions therein expressed.

EXPLANATION OF THE PLATES.

Plate III.

Fig. 1. *Producta gigantea*, Martin. Interior of the *ventral valve*, from which a portion of the beak has been removed so as to exhibit the umbonal cavity. A and C, adductor or *occlusor;* R, cardinal or *divaricator* muscular impressions. L, cavity occupied by the spiral arms.

2. ,, *gigantea*, interior of the *dorsal* valve. J, cardinal process. A, adductor or *occlusor* muscular impressions. W, projections, to which Mr. S. P. Woodward supposes the oral arms to have been attached (?). X, reniform impressions. Z, eminences corresponding to the hollows L in the ventral valve.

These two drawings are taken from valves belonging to the same individual, which was obtained from the Carboniferous Limestone of Llangollen, and is in the Museum of Practical Geology. It is one of the most instructive specimens which I have hitherto examined. The cardinal process was so much imbedded in the matrix that it could not be developed, so the deficiency was completed from a specimen in the British Museum.

3. ,, *gigantea*. Part of the hinge-line and upper portion of the cardinal process, from a specimen in the British Museum.

4. ,, *gigantea*. Ideal section of both valves (slightly improved), from the figure published by Mr. S. P. Woodward, at p. 233 of his "Manual of the Mollusca." The letters refer to the same parts in the other specimens.

5. ,, *semireticulata*, Martin. A fragment of the dorsal valve (enlarged), to show the beautifully marked adductor or occlusor muscular impressions (A), the projections W, and the commencement of the reniform impressions. From Redesdale, in Northumberland; in the Museum of Practical Geology. The cardinal process J, and the *septum* S, which are wanting or imperfect in the Survey specimen, have been correctly drawn from a similar but more complete example in the collection of Mr. Reed, of York.

6. ,, *longispina*, Sow.; from the Carboniferous shale of Karova (Russia), now in the Imperial Museum of Vienna, here given to show the great length of the spines. I am indebted to my friend Professor Suess, of Vienna, for this interesting drawing.

7. *Chonetes comoides*, var. (?) (*Producta hemisphærica*, Sow., according to Professor de Koninck.) A fragment exemplifying the great disproportionate thickness of the valves. B ventral, G dorsal valve. Along the weathered section of the ventral valve may be distinctly traced successive layers of shell, also small pits (K) along the cardinal edge, which were no doubt the tubular bases of broken spines. E, area.

This specimen is from Tidenham Chase (Gloucestershire), near Chepstow, in the collection of Mr. W. G. W. Ormerod.

Plate IV.

Figs. 1, 2. *Producta proboscidea*, de Verneuil. From the Carboniferous Limestone of Vise, in Belgium: to show the tubuliform prolongations of the ventral valve. (These two drawings are taken from Professor de Koninck's Monograph of the Genera Productus and Chonetes.)

Fig. 3. *Producta numerosa*, Sow. Internal cast of the ventral valve, from the Magnesian Limestone of the Carboniferous series of Breedon, Leicestershire. A and C, *occlusor*, R, *divaricator* muscular impressions. L, cones, which denote the deep hollows which existed in the interior of the immensely thickened ventral valve, and which were occupied by the spiral arms.

4. *Aulosteges Wangenheimii*, de Verneuil and de Keyserling, Sp. From the Permian Limestone of Mount Grebeni, in Russia.

5. „ *Wangenheimii*. Interior of the dorsal valve (enlarged). J, cardinal process. A, occlusor muscular impressions. W, oral processes (?) of Woodward. X, Reniform impressions. I am indebted to General Helmersen for these two beautiful examples.

6. *Strophalosia lamellosa*, Geinitz, var. *Morrisiana*, King. From the Magnesian Limestone of Tunstall Hill (Durham). H indicates the portion of the beak which adhered to marine bodies.

7. „ *Goldfussii*, Münster. A very remarkable interior of a *dorsal* valve, recently discovered by Mr. Kirkby, and forming part of his valuable collection of Permian fossils. The occlusor and reniform impressions project to an unusual extent. The sockets for the articulation of the valves are clearly seen on either side of the cardinal process, J.

8. „ *Goldfussii*, internal cast of the ventral valve, from the Magnesian Limestone of Humbleton Hill; showing the occlusor and divaricator muscular impressions.

9, 9ª. *Chonetes Prattii*, N. Sp. (?) Nat. size. This beautiful specimen (from the collection of Mr. Pratt) is here given as an illustration of the genus, on account of the admirable preservation of its valves. The specimen is silicified, and the valves can be as easily separated as in those of a recent species. Its locality is unfortunately unknown. The ventral valve is very deep, with a longitudinal depression along its middle; the dorsal valve is almost flat, with a small elevation towards the front; both valves are covered with minute striæ.

10. „ A portion of the same, magnified, to show the area of both valves; pseudo-deltidium, and cardinal process.

11. „ Interior of the *ventral* valve; A, *occlusor*, R, *divaricator* muscular impressions. The cardinal spines and their tubuliform orifices are here clearly exhibited.

12. „ Interior of the *dorsal* valve; *j*, cardinal process; A, and A′, anterior and posterior occlusor muscular impressions; *o*, ovarian spaces (?); X, reniform impressions. The granular prominences (described in the text) are here beautifully exhibited.

13. *Strophomena rhomboidalis*, Dalman. Showing the position of the *occlusor* and *divaricator* muscular impressions, as well as two conical subspiral prominences, L, which I suppose to have been produced by the mantle pressing upon the spiral arms, (?) as already described in the same valve of *Davidsonia*. Enlarged from a specimen in Queen's College, Galway, and which was originally communicated to me by Professor King.

14 & 14ª. *Strophodonta demissa*, Conrad, Sp. Exterior of both valves; from the Hamilton Group of Western New York, America. Fig. 14 shows that no fissure or pseudo-deltidium interrupted the regularity of the area in either valve; also the small, longitudinal striæ with which it is covered.

15. „ *demissa*. Interior of the *ventral* valve (enlarged), to show the teeth and small testaceous projections between them. A, occlusor, R, divaricator muscular impressions.

16. „ *demissa*. Interior of the *dorsal* valve. J, cardinal process.

A, A′, anterior and posterior occlusor muscular impressions. V, muscular markings.

I am indebted to Professor Hall, of New York, for these beautiful examples of his genus *Strophodonta*.

17. *Orthisina anomala*, Schlotheim, Sp. Exterior of the *ventral* valve, and area of the dorsal valve. E, area. D, pseudo-deltidium. F, foramen.

17*a*. Exterior of the *dorsal* valve.

18. „ *anomala*. Interior of the *dorsal* valve. A, A′, occlusor muscular impressions.

19. „ *anomala*. Interior of the *ventral* valve. These beautiful specimens were kindly given to me by Professor Dr. Schmidt, of Dorpat, and were obtained from the Silurian limestone in the neighbourhood of Reval.

20. „ *anomala*. A fragment of the interior of the ventral valve, from a specimen in the collection of Signor Michelotti, of Turin. For this drawing I am indebted to Professor Suess, of Vienna.

ON THE UPPER LUDLOW TILESTONES.

By George E. Roberts, of Kidderminster.

The Tilestone passage-beds between the Upper Ludlow rocks and those cornstones, now established as the natural base of the Old Red Sandstone, are, from the interesting character of their animal contents, attracting the greatest interest. I think it would be of value if the pages of the Geologist were open to detailed descriptions of the lithological character and fossils of these "Tilestones," as exposed in different parts of Shropshire, Worcestershire, and Herefordshire. A comparison may thus be instituted which would greatly aid our comprehension of them.

The Upper Tilestone series displayed in my own neighbourhood, is thus described in the new edition of "Siluria":—

"In the red ground, two miles north of Bewdley, near Trimpley, in Worcestershire, greyish coloured sandy grits and cornstones rise out in undulations, the cornstones charged with the *Cephalaspis Lyellii*, *Pteraspis Lloydii*; and the underlying grits with *P. Banksii*, *Pterygotus gigas*,* and eggs of this crustacean [?] (*Parka decipiens*) &c. with many remains of plants, including the small Lycopodiaceous sporangia."

This condensed matter I will now give in detail; for as every fossil found in the quarries has come before me, I have been able to secure the most important, and to take such notes of the others as would be of interest.

---

* *P. Ludensis, vide corrigenda.*

Trimpley is evidently connected in its physical elevation with the great upthrow of Palæozoic strata, along the line of which lie the Abberley and Malvern ranges. Of this ridge-line it would seem to be the northern limit. No true Silurian bed, however, is exposed along the strike of its anticline; but as the lowest measures of the Upper Tilestones, which form its backbone, are the exact equivalents of those resting against the north end of the Abberley Hill, micaceous shales, but fifty feet removed from Aymestry limestone, we can assume their presence not far beneath the axial line of the hill.

The ridge is flanked with true Old Red Cornstones, containing *Pteraspis Lloydii*, and *P. Lewisii*, *Cephalaspis Lyellii*, and defensive spines of Ctenacanthus or a related species. These fish-remains are coloured blue and purple by phosphate of iron, and glisten like enamel. Beneath these beds, somewhat unconformably, lie the Tilestones. Lithologically, they are grey flagstones, interstratified with bands of brashy cornstone (this, as far as I can yet learn, is a feature peculiar to the Trimpley beds). Fish and crustacean remains occur equally in both flagstones and cornstones, but the plant-remains form bands of themselves, intermediate between them. Beneath these lie micaceous shales, having surfaces bearing tidal ripple-markings and hollows. In the sheltered parts of these I have found Pterygotean ova (*Parka decipiens*) and a few drifted plants, but no fish or crustacean remains. These beds, at Abberley, cover up sandy grits, at the base of which I detected the Downton plant-beds, which contain the earliest land-plants.

To return to the Upper Tilestones: the fish-remains I have met with are these,—*Cephalaspis Lyellii*, heads only, but in very fine preservation; *Pteraspis Lloydii*, *P. Banksii*, *P. Lewisii*, and *P. rostratus*. Fragmentary remains are very abundant, but good and well-defined *shields* (I know not what else to call them) are rarely met with. The triplex character of the plates composing these defensive bony shells are beautifully preserved in nearly every specimen I have seen. I believe the Kington *Pteraspides* are remarkable for the want of these ornamental layers. *Ctenacanthus* (?) spines, and fragments of that substance of osseous character, supposed to belong to that Onchus, the spines of which (*O. Murchisoni* and *O. tenuistriatus*) are common in this bed. I believe, however, that these once supposed fish-defences will settle down into spines from the trifid tail of a crustacean; possibly the same Ceratiocaris whose curious structure, as displayed by the Lesmahago specimens, has been still further elucidated from the Upper and Lower Ludlow beds of Leintwardine and Burrington (near Ludlow). So that the fragments of *solid bone* given us by this deposit will have to look out for a new alliance.

Trimpley has been justly celebrated for its Pterygoti. The figures in the forthcoming Monograph by Mr. Salter (Geological Survey, Decade 10, pl. xiv. figs. 11, 12, 13), are taken from Trimpley specimens, valuable as giving portions of this remarkable Phyllopodous Crustacean not met with elsewhere. *Pterygotus Ludensis* and *P. problematicus* are the species of which I have found remains. Patches of the carbonized skin of Eurypterus I have also met with.

The plant remains are abundant, but their character is so far destroyed by carbonization that little or nothing can be made of them. Some of them may have had a growth *in situ*, upon the dimly seen shores of that ancient estuary, but of the greater portion of the remains we can speak but in the words of Hugh Miller, who describes their Scotch equivalents as being drifted from highlands of the period, "irregularly grooved stems, branching into boughs at acute angles, seeming miniature resemblances to the trunks of gnarled oaks and elms." There is nothing certain about them, and no special character visible. The spores of Lycopodiaceæ, however, are well preserved, and have such pretty polished surfaces that casual observers have carried away from the quarries all they could find. All that I have seen are identical in form.

This ends my list of Trimpley fossils. I should be glad to learn the fossil fauna and flora of their equivalent beds in other districts.

FOREIGN CORRESPONDENCE.

By Dr. T. L. Phipson of Paris.

Arsenic in Lignite and Bituminous Limestone, &c.—Professor Daubrée's Researches—Subterranean Noises—The Oldest Fossil Mammalia—A New Fossil Saurian.

Some years ago, M. Daubrée searched for arsenic and found it in many different kinds of rocks; but more especially in the mineral combustibles belonging to different strata.* He found at that time that the tertiary lignite of Lobsanu (Bas-Rhin), was uncommonly rich in arsenic: certain samples of this lignite were found to contain as much as from 0.002 to 0.008 of their weight of arsenic.

These observations have just been confirmed by the same eminent geologist, under certain circumstances that deserve to be made known. A limestone strongly impregnated with bitumen alternates with the lignite of Lobsann. This limestone forms the principal element of the bituminous mortar (*mastic*) employed in the locality for different constructions. For some years it has been employed also to obtain certain pyrogenous oils, which are produced by a process of distillation. When the alembics which have been used in this distillation are taken down, the interior of the tube through which the oils distil is often seen to be encrusted with a curious deposit, produced by the gradual condensation, outside the furnace, of certain volatile substances. This deposit, or sublimation, was found, upon examination, to be pure arsenic, crystallized in rhombohedrons; it attains sometimes as much as two centimetres in thickness, and in the course of some months, it will completely obstruct the necks of the retorts. The arsenic thus deposited forms about the one-millionth part in weight of the rock which is submitted to distillation.

The arsenic contained in the limestone is not entirely condensed in this manner; a notable quantity distils over with the oils, as M. Daubrée assured himself by a special investigation. In what state of combination the arsenic exists in these oils has not yet been ascertained; it is well to be aware, however, that arsenic does exist in them, as they are constantly employed for burning in lamps, &c.

The state in which this arsenic exists in the limestone of Lobsann, has, however, been ascertained with certainty by M. Daubrée, and in a very ingenious way. By the use of an appropriate solvent, the bitumen is dissolved out of the limestone; then the carbonate of lime is dissolved in its turn, when a residue, consisting of very fine non-crystalline particles, and amounting to about two per cent. of the weight of limestone employed in the experiment, is found to remain undissolved. These particles consist of *arseniferous iron-pyrites*. A fact that should be noted here is, that M. Daubrée formerly discovered arsenic in the limestone of the coal-formation at Villé, and found that it was contained in the rock as crystallized particles of Mikspikel ($Fe\,As + Fe\,S^2$), the small crystals of which were perfectly recognizable.

---

* See his *Recherches sur la présence de l'arsenic dans les Combustibles minéraux, dans diverses roches, et dans l'eau de la mer.* (*Annales des Mines*, 4e *série*, tom. xix. p. 669.) An extract was also published in the *Comptes-Rendus de l'Acad. de Sc. Paris*, xxxii. p. 827.

As regards the environs of Lobsann, it is not only in the beds of lignite and bituminous limestone that arsenic is found to be present. Near this locality there exist some masses of iron-ore, which are very remarkable as regards their geological position. One of them, at Kuhbrück, about two-and-half miles from Lobsann, furnished the blast-furnaces with an hydrated oxide of iron which contained so much arsenic, that it was found useless to smelt this ore any longer. These masses of iron-ore "have been developed," says M. Daubrée, "in a series of faults (*failles*) with which the formation of the bitumen in the tertiary formation is connected, as I have shown in another memoir, so that in these deposits of such different natures, but contemporaneous, the arsenic appears to have been derived from the same source."

We have called attention more than once in THE GEOLOGIST of last year, to the beautiful researches of M. Daubrée on Metamorphism, on the artificial formation of many minerals, &c.; and Professor Bunsen, at the last *Réunion of Naturalists*, at Carlsruhe, declared that for five-and-twenty years no work of so much importance for geology had been published, as M. Daubrée's researches on Metamorphism, &c. We wish, therefore, that it had fallen into the plan of the late President of the Geological Society of London to have noticed the labours of M. Daubrée, in his yearly account of geological investigations in all countries during the previous year (1857), and that he had thus added the weight of his testimony to that of the many eminent foreigners who have expressed their high opinion of M. Daubrée's labours, as the opinions and writings of English *savans* of so high a standing have a great influence on the Continent.*

As regards the very interesting note appended by the editor of THE GEOLOGIST to my last article, I must observe that I was aware that the noises of guns could be heard at considerable distances, and that even the sound of a bell has been reflected from the clouds. Thirty-two miles and 130 miles are certainly considerable distances to hear the report of cannon. But in advancing a conjecture, that the sullen noises sometimes heard on the western coasts of England and Belgium might have some connexion with the subterranean rumblings which accompany earthquakes and volcanic phenomena, I remembered having read that during the eruptions of the volcano on the island of St. Vincent (30th April, 1812) a noise like the report of cannons was heard, without any sensible concussion of the earth, over a space of 160,000 geographical square miles; and on the 23rd of January, 1835, during the eruption of the volcano Conseguina, in Nicaragua, a subterranean noise was heard at the same time on the island of Jamaica, and on the plateau of Bogotá, a distance greater than that which separates London from Algiers! As the editor of the GEOLOGIST justly observes, we cannot, however, be too careful in the manner of investigating these questions of noises.

---

* It must be remembered that the address which Dr. Phipson alludes to was delivered before the Geological Society in February of last year, and, if we remember rightly, very shortly, indeed, after the most interesting of M. Daubrée's researches were first published. It is somewhat unusual to notice "sins of omission" in the president of a society; but, as the remarks are evidently kindly intended, we publish them, in order that it may be fully known on the Continent that M. Daubrée's researches are not by any means slighted by English *savans*. Indeed, they were noticed with much emphasis by the present President of the Geological Society, Professor Phillips, in the anniversary address delivered a few days since.

It is time now that we should turn our attention a little to some palæontological researches that will perhaps be read with interest. The following concerns the oldest fossil mammalia.

It was in the oolitic beds of Stonesfield that, more than forty years ago, the first remains of mammalia older than the tertiary formations were discovered. This discovery was looked upon with suspicion by many naturalists, who could not believe in the existence of mammalia at such an early date.

"In spite of the authority of the justly celebrated naturalists who regard the Stonesfield fossils as true mammals, we cannot help cherishing some doubts," M. Alcide d'Orbigny writes, in 1850, in his excellent *Cours élémentaire de Paléontologie et de Géologie Stratigraphiques;* "in studying comparatively the animal forms of each series, we have found that the exceptions were generally based upon inexact determinations. . . . Why, if they be really mammalia, have not the bones of the head, or any of the bones connected with the jaws even, been described, that the determination of the animals might have been confirmed thereby? . . . We think either that the animals themselves belong to the class of reptiles, as others have already thought, or that the lower jaws, being one of the narrowest parts of the skeleton, must have fallen from the tertiary beds into the crevices of the Jurassic strata."

These scruples were never indulged in by Georges Cuvier. "In the month of February, 1832," says M. Elie de Beaumont, "in spite of the contrary insinuations by which it was endeavoured to efface a fact standing out as an anomaly to the laws established by him, Cuvier one evening took from his collection one of the jaws found at Stonesfield, and demonstrated in his own drawing-room that this bone belonged to a mammal, and that it could not possibly have formed part of the skeleton of any of the Saurian tribe. As to the geological position of these fossils discovered by Broderip and Buckland, M. Cuvier never had the slightest doubt of it."

The age of the Stonesfield fossils, nevertheless, remained for a time an object of doubt, when a new discovery rendered extremely probable the antiquity which their natural position in the earth's crust assigned to them. The discovery in question was made in the Purbeck-beds, which, belonging to the upper Oolitic series, lie between the cretaceous formation and the Stonesfield strata. Fourteen species of mammalia, belonging to eight or nine genera (*Spalacotherium*, *Triconodon*, *Plagiaulax*, &c.) were found there.

Such was the state of things when another discovery was added to those of which the authenticity had been so much questioned, and obliged us to place the date of the first appearance of mammalia considerably farther back. It was made by M. Plieninger, who found at Stuttgard some minute teeth of a new fossil mammal, a type of a new genus, that of *Microlestes*, which he discovered at the junction of the Triassic and the Liassic strata. Hence, the *Microlestes* is considerably more ancient than the Stonesfield fossils.*

If any doubts still remain, however, concerning this great antiquity of mammalia, they will perhaps be dissipated by a letter which Mr. Pentland has just addressed to M. Elie de Beaumont.

"It will be interesting to know," writes Mr. Pentland,† "that there have just been discovered in the 'Bone-Bed' of Dundry, near Bristol,‡ which belongs to the superior Triassic beds, some indubitable remains of mammalia belonging to the family of Insectivora, and which Owen is inclined to connect with the genus *Microlestes* of M. Plieninger, formerly discovered in Germany. It is believed that their true position is of more ancient date than the Lias, and they are certainly the most ancient fossil mammalia known to palæontologists."

M. Elie de Beaumont observes that one doubt only can prevail concerning the geological age of the "Bone-Bed" of Dundry; it is, whether this bone-bed is really part of the Trias, or whether it constitutes, on the contrary, the first stratum of the Lias which covers the former. However this may be, the discovery made at Dundry entirely confirms that made at Stuttgard. "Thus it is," says M. Elie de Beaumont, "that the progress of observation, whilst multiplying in so surprising a manner the mammalia of the tertiary formations, shows us that they penetrate, though in much smaller numbers, and of much smaller size, into the secondary strata, where they reach, to say the least, as far as the base of the Jurassic rocks, and where probably they will not stop. These new discoveries of fossil mammals tend naturally to render less surprising the impressions of birds' feet in the variegated sandstone on the banks of the Connecticut;* and these observations are in perfect harmony with the discoveries of the remains of Saurians, which, after stopping for a long while at the German Zechstein, and reaching afterwards to the coal-formation, have at last furnished us with *bones of crocodiles* in the uppermost Old Red Sandstone† of Scotland, without speaking of the impressions of footmarks already observed in the old red sandstone‡ of the Alleghanies, and in certain sedimentary rocks, probably more ancient still, on the borders of the great lakes of North America.§ And again, by a sort of contrary progression, certain organic forms, originally regarded as characterising some of the most ancient sediments (*Orthoceratites*, *Spirifer*, *&c.*), have lately taken an incontestable place in the *Couches Keuperiennes* of St. Cassian, and in the Lias of other countries. Far from lessening palæontology, these discoveries, on the contrary, enlarge its boundaries, which were formerly established on a plan both narrower and less rational than that which progressive observation points out to us."

---

* The *Dromotherium sylvestre* of Dr. Emmons is another of these "oldest" mammals; and two or three jaws have been obtained from the shales associated with coal-beds in North Carolina, which are certainly of Triassic, and possibly *Permian* age!—Ed. Geol.

† His letter is here translated from the French.

‡ By Mr. Charles Moore, F.G.S., of Bath. See "Siluria," new edit. p. 514. Sir Roderick Murchison says these remains were found "in an agglomerate which fills the fissures of the carboniferous limestone near Frome, Somersetshire;" meaning thereby, we believe, what is usually known as "the dolomitic conglomerate."—Ed. Geol.

A new Saurian has just been discovered in the Permian strata of Lodève, in France. The slate-rocks of Lodève, essentially formed of Permian schists, had never before presented us with any but vegetable fossils. M. Paul Gervais, the distinguished naturalist of Montpellier, has, however, just discovered in them a new species of lizard, which he calls *Aphelosaurus Luterensis*. This animal belongs to Paul Gervais' family of *Homeosaurides*, a family formerly established for certain reptiles which, up to the present time, had not been found out of the more modern of the Jurassic strata.

The size of the *Aphelosaurus* is about that of the largest occelated lizards that have hitherto been found in the south of Europe; it may also be compared to that of the Varans and Iguanas of average dimensions.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London, *February 2d*, 1859.—The following communication was read:—

"On the Mode of Formation of Volcanic Cones and Craters." By G. Poulett Scrope, Esq., M.P., F.R.S., F.G.S.

The author commenced by saying that he should not have referred again to this subject, already briefly treated by him in a paper read to the Society in April,

---

* See our article in the Geologist for January and February, 1858.—T. L. P.

† The exact age of the sandstone at Elgin, in which the remains of *Stagonolepis* occur, is as yet a question among the best geologists acquainted with the district. —Ed. Geol. See also the Geologist, Vol. II. pp. 46 and 89.

‡ This red sandstone, termed "Old Red" by Dr. I. Lea, belongs to the Lower Carboniferous series, according to the Professors Rogers.—Ed. Geol.

§ M. E. de Beaumont probably here alludes to the tracks in the Potsdam sandstone, and described as being those of Crustaceans by Owen and Logan.—Ed. Geol.

1856, had it not been that Baron Humboldt, in the recently published fourth volume of his "Kosmos," applies the whole weight of his great authority to the support of the theory of upheaval in contradistinction to eruption as the *vera causa* of volcanic cones and craters,—a theory which the author, with Sir Charles Lyell, M. Constant Prévost, and many others, believes to be not merely erroneous, but destructive of all clearness of apprehension as to the character of the subterranean forces, and the part which volcanic action has played in the structural arrangement of the earth's surface.

He showed, by reference to the works of Spallanzani, Dolomieu, Breislak, &c., that the early observers of volcanic rocks and phenomena, together with the unscientific world, looked upon volcanic cones and craters, whether large or small, as the result of volcanic eruptions; but that of late years a new doctrine had been propagated by MM. Humboldt, von Buch, Elie de Beaumont, and Dufrénoy, which denies altogether that volcanic mountains have been formed by the accumulation of erupted matters, and attributes them solely to a sudden "bubble-shaped swelling-up" of pre-existing horizontal strata,—the bubble sometimes bursting at top and then leaving its broken sides tilted up around a hollow (elevation-crater).

The author expressed his belief that this notion originated in Baron Humboldt's account of the eruption of Jorullo in 1759, in which (as the author showed in his work on volcanos of 1825) a great error had been committed,—the convexity of the Malpais and its five hills being simply a bulky bed of lava poured out on a flat plain from five ordinary cones of eruption, and the "hornitos" common "fumaroles" coated over with black mud produced from showers of volcanic ashes mixed with rain-water. But the idea of a "bladder-like swelling-up" of horizontal strata into volcanic hills being thus started by M. von Humboldt, it was further extended by M. von Buch; and hence arose the "elevation-crater" theory.

The author next proceeded to show the inconsistencies of the advocates of this theory, who disagree among themselves as to the extent to which they apply it,—MM. Humboldt, von Buch, and Dufrénoy asserting both Somma and Vesuvius, the Peak of Teneriffe, and all Etna, to be solely due to sudden upheval, while M. de Beaumont declares Vesuvius, the Peak, and the upper cone of Etna to be the products of eruption only. Again, while, except M. Dufrénoy, all admit the minor cones and craters of Etna, Vesuvius, Lanzarote, and Central France to be eruptive, all declare the similar cones and craters of the Phlegræan fields to be due only to upheaval. They offer no reliable test by which upheaved can be distinguished from eruptive cones; or, when they attempt this, differ again from one another, and even from themselves. Thus, Von Buch considers the extreme regularity of the slopes of Etna a proof of its upheaval. M. de Beaumont asserts regularity of outline to be the distinguishing feature of an eruptive cone, and yet declares the upper and the lower portions of Etna, which are its least symmetrical parts, to be of eruptive origin, and the intermediate cone, the slope of which is extremely regular, to have been upheaved! In respect to the tuff-cones and craters of the Phlegræan fields, the series from Somma to the Monte Nuovo is so evidently of similar character, that, to avoid classing the first as an eruption-cone, the upheavalists have been driven to deny that the Monte Nuovo itself was the product of eruption, and even to assert that it existed in the Roman era, and was only sprinkled with a few ashes by the eruption which, from all contemporary authorities, threw it up in two days of the year 1538! The author describes the circular anticlinal dip of the strata of the Monte Nuovo and other tuff-cones of the Campi Phlegræi as utterly inexplicable upon the theory of upheaval, while it is the natural result of the fall and accumulation of fragmentary materials projected upwards by eruptions.

He then disputes the truth of M. de Beaumont's dogma, that lava cannot consolidate into a solid bed upon a slope exceeding 5° or 6°, and shows from numberless instances in Auvergne and the Vivarais, on Etna, Vesuvius, Teneriffe, &c., that bulky beds of lava have congealed on steep slopes,—in some cases, as for example in that of Jorullo itself, in the form of a massive promontory projecting far from the side of the cone of the crater from which it issued; in others, when liquidity was at the *minimum*, in that of a dome or bell (Bourbon, Puy de Dome,

&c.). In regard to Etna, he leaves M. de Beaumont's misrepresentations of fact to be dealt with by Sir C. Lyell, only remarking that, on M. de Beaumont's own showing, the portion of Etna which he supposes to have been upheaved, is positively "encrusted with a coating of lavas."

The inapplicability of the elevation theory to the Cantal, Mt. Dore, and Mezenc in France, is then shown, inasmuch as, by M. de Beaumont's own admission, the angle of slope of their basaltic and trachytic beds is even less than that of the recent and acknowledged lava-flows in the same district. Finally, he asks what has become of the products of the repeated eruptions of volcanos, if they have *not* accumulated in the course of ages into the mountains which we find there, composed of irregular alternating beds of lava and conglomerate just such as we see to be erupted from the central orifices?

The author next shows that the upheavalists have no correct idea of the mode of formation of craters, which are not formed, as they assert, at one blow, by a single explosion, like the bursting of a bubble, or of a mine of gunpowder, but by the repetition of explosions or flashings of steam from the surface of ebullient lava within the volcanic vent (like those of a colossal Perkins's steam-mortar), continued for weeks and months, or more, by which the mountain is often ultimately eviscerated, its summit and heart being blown into the air, and scattered in fragments or ashes around—*not* foundering into the cavity and remaining there as they represent. He instances the great crater of Vesuvius formed under his eyes in 1822 by explosions lasting twenty days; and judging from the quantity of fragmentary matter then ejected and falling around, comparing it with the far greater quantities thrown up occasionally by eruptive paroxysms in other quarters of the globe, he asserts his belief that in the latter cases craters may be, and are, formed of several miles in diameter, nothing remaining of the whole mountain except the wreck of its base, as we see in Santorini, the Cirque of Teneriffe, and so many other circular cliff-ranges surrounding extinct or active volcanic vents. He expresses his astonishment that Von Buch and Humboldt should have supposed Vesuvius to have "sprung up like a bubble in one day, just as we now see it," in the year 79 A.D., and not to have increased since; and shows that even within the last hundred years great changes have taken place in the form of that mountain, and that the relation of Pliny of the phenomena witnessed by him is inconsistent with the idea of upheaval, and demonstrative of the occurrence of an eruptive paroxysm by which the upper part of Somma was blown by degrees into the air, and the crater of the Atrio formed, in which the subsequent eruptions of eighteen centuries have raised up the cone of Vesuvius.

In recapitulation, the author declares that the characters of all volcanic mountains and rocks are simply and naturally to be accounted for by their eruptive origin, the lavas and fragmentary matters accumulating round the vent in forms determined in great degree by the more or less imperfect fluidity of the former, which, as in the case of some trachytic lavas, glassy or spongy, may and do congeal in domes or bulky masses immediatelv over, or in thick beds near the vent, or, as in that of some basaltic lavas, may flow over very moderate declivities, to great distances; and consequently that the upheaval- or elevation-crater theory is a gratuitous assumption, unsupported by direct observation and contrary to the evidence of facts. He concludes by representing its continued acceptance to be discreditable to science, and an impediment to the progress of sound geology, inasmuch as false ideas of the bubble-like inflation, at one stroke, of such mountains as Etna or Chimborazo must seriously affect all our speculations on Geological Dynamics, and on the nature of the subterranean forces by which other mountain-ranges or continents are formed.

NOTES AND QUERIES.

Glacial Action in Wales.—"At the mouth of a lateral valley opening into the vale of the Ithon, in Radnorshire, at the turnpike-gate above Llanbadarn Fynydd, there is a low hill somewhat in advance of the slopes of the underlying schistose rocks. A road-cutting exposes a section of this hill about fifty feet from its base, and the same from its summit. It is seen to be composed of materials far different to those of the soft coarse rocks around, being, in fact, a collection of boulders and angular fragments, with smaller pebbles and mud. The excavation made by the stream at the base of the hill shows the same confused collection of large stones, little-rolled, with coarse detrital material. The boulders are principally gritty portions of the Silurians found in the hills at the sources of the stream. The residual products of a glacier appear to be here apparent.—S. R. P."

Mammalian Remains.—"Dear Sir,—The remains of Mammalia in the Dover Museum are very few, and are mostly those of Mammoth. The collection consists of, large tusk of Mammoth, another large tusk, apparently of a different species, trawled up in the North Sea, off Holfordness; remains of Mammoth, and large stags' horns, from Faversham; Elephants' grinders, dredged up on the Calais oyster-ground, off the French coast; part of upper portion of a bear's skull, from the Cherry Gardens, Folkestone; cores of horns of Bos, from Faversham; remains of Mammoth and of Bos, from Herne Bay.—Yours, &c., Charles Gordon."

Landslip at the Isle of Portland.—"In the Isle of Portland, early on Sunday morning, December 26th, an unusual kind of noise was heard by some of the inhabitants at the village of Chesil, compared, by the narrator, to the continual falling of a stone wall. On the return of daylight it was found to have proceeded from the sliding away of a large extent of under-cliff, covering an area of from twenty to twenty-five acres, which had caused the sinking of an enormous mass of broken stone, the *débris* of the adjoining quarries, and the accumulation of very many years. The scene of the occurrence is on the west side of the island, overlooking the great west bay, about 200 or 300 yards from the village of Chesil. A slight sinking had been observed by one of the quarrymen on the previous afternoon, but it was not until an hour after midnight the general mass gave way. The main cliff, or escarpment, is, at this point, about 200 feet above the level of the sea; the north end is 495 feet, but with a considerable southerly dip. The upper strata of the Isle of Portland are the Purbeck, or fresh-water limestone, alternating with layers of clay or dirt, as it is here called; one of which seams contains the fossil trees and *Cycadeæ*. Below this is the true Portland-series, consisting of beds of stone interspersed with bands of chert and flint, and terminating with the Portland-sand. Below all these the Kimmeridge-clay—the formation which yields the well-known bituminous schist—forms the general substratum of the island. It forms the anchorage ground of the Portland roadstead, and is the stratum on which the Chesil-beach has accumulated. The immediate cause of the landslip undoubtedly has been the action of the springs from behind and above passing through the numerous fissures in the beds of solid limestone, and carrying away in their course the soft and yielding clay; and thus undermined, the superincumbent mass has sunk downwards and outwards. In ascending from the beach, the visitor will be first attracted by the low under-cliff of Kimmeridge-clay, which, from lateral pressure, has been pushed forwards beyond the beach into the water, and forced upwards with the shingle over it, so as to present an escarpment, or outer face, towards the sea. The condition of the displaced under-cliff is, more or less, the accompaniment of all landslips on the coast, and was remarkably exhibited in the great landslip near Lyme Regis, December 25th, 1839. On that occasion, the argillaceous stratum of under-cliff was tilted up to a height of thirty feet, leaving a corresponding depression behind, which soon became filled with the fresh water issuing from the main land. At Portland, a small pond only has been formed. A little way up the cliff, a singular change has been effected in the condition of some garden-plots, which were previously inclined towards the sea, at an angle of about forty-five degrees, but now dip in the opposite direction; the plane of this portion of land having traversed ninety degrees, or one-fourth of a circle. The entire ground, from the beach upwards, is rent with innumerable cracks, from a few inches to several feet in width, and in lines parallel to the coast, rising in a series of steps or terraces. On reaching the summit, other effects are visible, especially to those familiar with the locality. For many years past the waste material of the neighbouring quarries has been here thrown from trucks over the cliff, and had formed there a kind of causeway, extending about forty feet; all this has sunk bodily down into basin-shaped cavities, carrying with it portions of the main cliff. Either from the sudden withdrawal of this enormous mass, or the undermining below, a partial severance of a large part of the solid cliff has been effected. At present, the crack is but a few inches in width, and the opinion among the more experienced quarrymen is, that at present there will be no further displacement beyond a slight settlement. Should this ever be detached, the crash would be tremendous, and be attended with danger both to life and property. The east side of the island has in past years been the scene of many extensive landslips, some of which are recorded in Hutchins' 'History of Dorset.' On the 2d February, 1615, the pier was demolished, blocks that lay forty yards off in the sea were raised above the water, and the ways leading from the pier to the quarries were turned upside down. The earth for one hundred yards sank into the sea. It was conjectured that this, too, was caused by the weight of rubbish thrown over the cliff upon a foundation of clay. After an exceedingly wet season, in December, 1734, another landslip occurred, when one hundred and fifty yards of the north-east end of the island sank into the sea, by which a pier and road were destroyed; the damage being computed at £46,000. A still more destructive one occurred in February, 1792, when the extent of ground moved was a mile and a quarter in length, and six hundred yards in width. One effect of these slips on the east side of the island has been to bring down the old burying-ground from the level of the land above to within a few feet of the sea. The insulated condition of large portions of cliff near Pensylvania Castle, are due to the same cause. The whole offers a good illustration of the wasting process of land-springs, when acting on formations such as the Oolitic, in which the stony beds are interspersed with bands of clay and sand."

REVIEWS.

The Earth and the Word; or, Geology for Bible-Students. By S. R. Pattison, F.G.S. London: Longman and Co. 1858.

The Primeval World: a Treatise on the relations of Geology to Theology. By Rev. Paton J. Gloag. Edinburgh: T. and T. Clark. London: Hamilton, Adams and Co. 1859.

These are two charming little books upon subjects to which, of late years, the Christian public have looked with great interest, and upon which some of our best geologists and theologians have spent much study and labour. Every effort to bring about a reconciliation of the biblical account of creation with the truths of geology is to be praised and not condemned; at all events, a thorough and constant discussion of all the points of coincidence or difference must be productive of beneficial effects.

Many, indeed, of the Protestant clergymen of our own land are those who have not feared to become geologists, nor have hesitated to believe that neither the testimony of the Bible in its proper or moral aspect could be invalidated, nor the stability of true religion shaken, by the teachings of science.

To Mr. Gloag is particularly due the praise of having dared to view every subject —and we say it sincerely, whether we concur in all his views or not—in a bold and truthful manner, and without apparently the remotest desire to garble any topic to his own purposes, or to pander to any prejudices. "It is," he says in his commencing words, "a Christian duty to meditate upon the character of God, not only as exhibited in grace and redemption, but also as displayed in creation. God is the Author of nature as well as of revelation. His existence is declared and his perfections are manifested in the one as well as in the other, and therefore both claim our devout attention and earnest study."

The first half of the work is an epitome of geological doctrines; the following passage, describing the order of organic remains, well exemplifies that intelligibility of language and admirable brevity, simplicity, and accuracy by which Mr. Gloag's writing is characterized:—

"And now let us endeavour, if possible, to realize these facts which we have stated. Let us travel in imagination into the distant past. Let us fix our attention upon a small portion of the earth. It is the ocean-bed. Fish of peculiar shape are swimming about it; some with fins spread like wings, and others with huge scales like a coat of armour. In general they are carnivorous, and prey upon their fellows. Ages roll on. These fish have ceased to exist; their remains have been embedded in the mud or sand at the bottom of the ocean; this has been consolidated into stone, and has been gradually elevated until it forms part of the dry land. And now we are led, as it were, into a different world. Gigantic ferns or reeds, like trees, now grow upon the earth. A vegetation has sprung up far ranker and more luxuriant than that which we read of in tropical climes; but not one tree, not one plant is the same as any which now exists. Ages again roll on. The vegetation has disappeared; the trees have been swept into the ocean, or the ground on which they grew has been submerged; the dry land has again become sea. And in that sea we behold strange shapes and forms—huge reptiles and terrible monsters of the deep; there is one, at least thirty feet long, with a neck longer than that of any swan, a head of a lizard, a body of a crocodile, and the paddles of a whale: there is another, a flying monster, a reptile covered with scales, with wings similar to those of a bat, rivalling in its shape any of the fabulous dragons of antiquity. But their existence also has its limits; the species dies as well as the individual; the age of reptiles has come to its close; and after ages upon ages have passed away, after another series of elevations and submersions, after this portion of the earth has been sea and land alternately, it is ultimately raised, and peopled with created intelligences, and is the seat of the mightiest empire that ever existed upon earth, and has become the abode of civilisation and religion; for this portion of earth, the past history of which we have traced, is a part of the island of Great Britain.

"Every formation has, of course, been formed at the bottom of the sea, and is, therefore, a decisive proof that the district where it is now found once constituted the ocean-bed. It is also a proof that dry land and sea existed contemporaneously, for the materials of which the formation is composed were all originally washed off from the land; and thus in past geological eras, whilst the stratified rocks were deposited, there never was a time when all was land or when all was water. Indeed, every portion of the dry land has, in all probability, been frequently at the bottom of the sea. 'By an abundance of various complicated evidence,' says Dr. Pye Smith, 'it is proved that there is probably no spot on the face of the earth, both the dry land and the seas as they at present exist, which has not gone repeatedly through the conditions of being alternately the floor of the waters, and an earthy surface exposed to the atmosphere and occupied by appropriate tribes of vegetable and animal creatures.'"

In Chapter IV. the consideration of the Mosaic days of creation is taken up, and the creation of the world is put by the author at that beginning which may now be regarded as popularly considered to have been divided by a lengthened period of vast ages from the six days of the Mosaic account. "The sacred Scriptures," writes Mr. Gloag, "open with a description of the creation and arrangement of the universe—a description which, for the unity of simplicity of diction with sublimity of thought, is probably unequalled by any composition. The first sentence contains a comprehensive statement of the creation of the universe. It reveals God to us as the Creator of heaven and earth, the Great First Cause, the

Source and Origin of all existence." The various theories and schemes of reconciliation of various writers are then reviewed, and the meanings of the terms *creation*, *days*, *earth*, in the senses used are duly weighed; but after a careful comparative analysis of the interpretations and modes of reconciliation as yet proposed, with the concurrent geological facts, the author concludes that we must "regard all attempts at the discovery of an adequate theory of reconciliation for the present hopeless," and especially he regards as a barrier to an immediate settlement of a satisfactory solution, the admitted ignorance of geologists as to the precise state of the earth, immediately before the present creation. In leaving the subject thus open, Mr. Gloag takes good ground in the expressed conviction that both the geological facts, when fully demonstrated, and the scriptural declarations, when properly interpreted, are founded on truth, and cannot possibly contradict each other. "We need be under no apprehension," he properly says, "that true science shall ever be opposed to revelation. The Word of God is not contradicted, but illustrated by his works. This has ever been the case in past ages; and this will ever be the case in ages to come. Scripture does not shrink from the strictest scrutiny, nor is it at all afraid that any discovery of science shall either weaken its evidence or contradict its statements."

The author then passes on to reflections on the existence of death before sin, the scientific view of the Deluge and the scriptural statements in reference to it, and then devotes the remaining portion of his eloquent little book to the illustration of the Divine benevolence as displayed in the pages of geological history.

We rejoice in the production of such inexpensive works, when characterised by the information and candour so especially marked in this, and we heartily wish "The Primeval World" an extended circulation, from the belief that its pages will nowhere be perused without pleasure, and by no one without advantage.

Mr. Pattison's is a still smaller book than the one we have just reviewed, but it is by no means its inferior in diction or matter, and is characterised by a peculiar poetical vein of writing. The author tells us that it is not another attempt to construct a scheme of reconciliation which shall satisfy all parties, nor a new theory of interpretation either of the earth or the Word of God; but an endeavour to consider both records together with equal reverence as being of equal authority. "Undoubtedly," he says in the Preface, "the minds of many good men are uneasy at the suspicion of a conflict between the testimonies, just as on the eve of an important trial the young advocate is distressed by the prospect of contrary evidence equally credible. But in both cases the open examination removes, one by one, all the apparent discrepancies, and truth comes out all the more illustrious for the clouds which beset its course."

Mr. Pattison opens his book in an easy flowing style, which is maintained throughout. "From some eminence, ascended in the course of our autumnal ramble, we see the green earth spread out before us as a map. Its aspect, colour, composition, and arrangement, suggest design; we ask, was it made for us?—by whom?—and when? Memory brings to our recollection the offerings made by 'mother earth' to our material well-being, and we readily conclude, that the requirements of man had something to do with its origin and plan. The shrewdest observers and most profound thinkers in all ages, who have investigated the condition of the earth, have arrived at the universal conclusion that 'the hand that made it is divine.' From the deepest mines and loftiest mountains, from primeval rocks and alluvial plains, from liquid ocean and ambient air, the testimony springs up, 'In the beginning God made the heavens and the earth.'"

From the cosmogony of the subject the author proceeds to a brief review of the succession of strata forming the earth's crust, with the remains of former creations entombed in them, and the value of those mineral masses to the necessities and uses of mankind. The arrangement of the rock-masses is then more minutely dwelt upon, with a view to show "the one property which belongs to all the varieties of material, namely, utility to man. As civilisation advances, one and another instance of this is discovered, and brought into practical demand in the common life of the world's population. We daily avail ourselves, in a thousand ways, of the vast stores of mineral matter laid up and prepared for this end amidst the slow processes of anterior time."

The subject of Palæontology is then taken up, and regarded in the light of the continuance of God's creative energy and providence; each successive life-stage being subjected to analysis and special notice in descending series from the most recent with the remains of man and of his works through the ages of great beasts, of gigantic reptiles, of profuse vegetation, of trilobites, to that of primeval worm-tracks and rain-drops. Everywhere in these rocks "we find the clearest evidences of adaptation in the character of the animal-remains of their successive beds. One kind of life flourishes in the fine shales, the consolidated impalpable mud of the early seas; another affects the coarser sandstone, loving the littoral conditions suited to its existence; a third abounds only in shell-sand; whilst the most numerous occupy the calcareous zones, which are the chief sepulchres of the remote past." The first appearance of every creature in the geological scale is not in a rudimentary or imperfect condition, and so sudden has sometimes been the addition of life that one band of the Upper Silurian Formation—the Niagara limestone—presents us with 150 new species. The results of extensive observations in various regions show that marine species in the olden geological periods had a wider range than those now living, so that the climatal or physical conditions of the ocean over large areas must have been more uniform, although particular localities were characterised by the predominance of particular forms. Thus lifting the curtain of the past, we are struck by the endless procession of animated existence appearing on the stage, moving slowly across it, and visibly ending, not by worn-out life, but by changed conditions, nor "can we announce that there have been absolute life-breaks, for evidence is continually coming in, showing that such lines do not exist, or if existing in one district, do not extend to others."

"The study of Geology puts to flight for ever the opinion that God has rarely, if ever, been actively employed in *creation* since the issuing of His fiat for its commencement. There have been no long periods of inaction, positively no repose whatever of Divine power, no trace of quiescence, no proof of abandonment for a moment."

From these reflections the author's thoughts turn hopefully to futurity, and he concludes "if He has thus cared for the material universe from all eternity, so He will for the moral, and the traces of continual provision for the one may be well appealed to as tokens of assurance for the other. It is not, therefore, as a stranger that the geologist opens the Word of God."

The fourth chapter deals with the history of our globe. In it, of course, the high antiquity of our planet is dwelt upon, and a pretty illustration of this is thus pleasingly given: "Just as we should learn much of the history of England by tracing the fortunes of one of our aristocratic families backward to the Norman man-at-arms who came over with the Conqueror, so we may obtain a lively impression of the sequences in the geologic past by tracing the fortunes of any family which has survived from the earliest times to the present, in the palæontological roll." And so Mr. Pattison selects the Lingula, and traces the family-pedigree back from the tiny molluscous inhabitant of the Polynesian coral-reefs "beyond the time whereof the memory of man runneth not to the contrary," beyond "legal memory, whose boundary is the departure of brave Cœur-de-Lion to the Crusades—beyond Herodotus, the father of history, from before the voyage of the good ship Argo, it has been living and flourishing unknown to fame." "It may have attracted the attention of the world's grey fathers in their boyhood; but it claims a still higher ancestry, for we find it in pre-historic times." Backward in time the pedigree is traced—among the crag shells, in the sands of the cretaceous sea, we find it "in the region of the oolites, it takes its place with the coral then growing over the new-made grave of the gigantic saurians, beyond still with the marine fossils of the mountain limestone,—in the Devonian and Silurian rocks," but we must still press on, "for the little Lingula ascends to the utmost limit of organic life;" and thus, by the aid of Geology, "we carry back into untold ages the evidences for God, which the naturalist so triumphantly gathers from the creation around." "Palæontology and mineralogy both tell us that the world has a history not recorded, because not professed to be recorded in the Scriptures; and that the great actor in this history was unquestionably God, 'blessed for evermore.' He has in the Bible given us adequate information to make wise unto salvation, but has left for the present untold much of the great story of his love." The sequence of this chapter is naturally the "exposition." "In the beginning God created the heaven and the earth" is the starting-point of both theologists and geologists—indeed, of all mankind. Concurring in the interpretation of a great "interval in which all pre-historic geology finds its place," our author proceeds to the second verse of the Mosaic narrative, "And the earth was without form and void; and darkness was upon the face of the deep," and considers that this "was not a phenomenon preceding all order whatever, but a marked interruption in the sequence of physical events." The Spirit of God moving upon the face of the waters he regards as the putting forth of the Divine energy for the commencement of the present state of things, which differs as a whole so much from any antecedent condition, that it can well be called a new creation. "Light was now made to appear; *first* as to the darkness out of which it immediately sprang, and *first* with reference to all that of which it was the introductory manifestation." "On the second day, the present atmospheric arrangements were restored and developed; differences of climate had been produced long before; but out of the condition of disorder and dark miracle of verse 2, now again were evolved, at the fiat of the Almighty, the play of the great system of exchange, whereby the clouds "drop down fatness." On the third day, "The present geography of the earth's surface was made apparent, and then the creation and growth of vegetation in soils which had been prepared in previous pre-historic epochs." Day four—"The unveiling, in the now lucid atmosphere, of the sun, the moon, and stars, in perpetual connexion of forces and influences with the earth—not the original establishment, but the first manifestation as regards the earth's present surface." In the fifth verse, it is considered, we have narrated to us "the creation, as a whole, of the present assemblage of aquatic animals and of birds." The fifth day is viewed as a narration of the creation, as a whole, of the present assemblage of aquatic animals and of birds, and here we would transcribe one remark as highly pertinent. "It is owing," runs the passage we allude to, "to the creation of everything, 'after its kind,' both in this and in the previous stages, that we can advance with unfaltering footstep into the domains of the dead, to pronounce with confidence concerning the true character of the relics." "Among the most antique things we can gaze upon are the familiar *forms* of the creatures around us. In unvarying similitudes have they been preserved and transmitted from the first."

The passage describing the transactions of the sixth day, "informs us of the creation, as a whole, of the living species of reptiles and animals, and lastly of man himself."

The second chapter of Genesis is regarded as "a summary of the work of creation as relating to the present condition of the earth, with special reference to the appointment of a day of rest, and the primeval history of mankind," and in a scientific point of view, "as confirmatory of the conclusion derived from natural history, that no new species nor any new substance has been created since the period here indicated."

After just considerations of the difficulties besetting the reconciliation of the two accounts, and of the probably partial character of the Deluge, the geology of the "Scripture Lands," and the bibliography of the subject of the treatise, conclude this interesting book.

Some points in both books, as in all works of this class, may seem strained to meet a special purpose, and others to have an unnatural appearance, still both authors have made good selections of the best published ideas upon these important discussions, and have added many sensible remarks of their own; and we would end our review by re-echoing the concluding remarks of Mr. Pattison. "And should it be, that after all these efforts, somewhat of obscurity still hangs over the subject, we will believe in the goodness and wisdom of God notwithstanding, endeavouring to walk humbly, and therefore surely, before Him."

Illustrations of the Geologic Scenery of Purbeck.
Illustrations of the Geologic Scenery of Weymouth, Portland, and Purbeck.
Illustrated Historical and Picturesque Guide to Swanage and the Isle of Purbeck.
By P. BRANNON. Sydenham, Poole; London, Longman & Co.

THE humblest effort deserves commendation and support when it is made in a right spirit. We confess to a weakness for letter-head views and those cheap lithographs and engravings, which provincial booksellers so abundantly display as baits for the small silver superfluities of the stranger's purse.

Common in execution as many of these are, they are more quickly purchased than sketches could be made even by expert draughtsmen, and they serve years afterwards to remind us of the famous or cherished spots, which we, like other pilgrims on the road of Life, have chanced to visit.

The above set of *brochures* which the author has forwarded to us, are illustrated amply with engravings of the letter-paper class, but of far better execution than the average of such productions. The "Illustrations of the Geologic Scenery of Weymouth, Portland, and Purbeck," and "Illustrations of the Geologic Scenery of Purbeck," each contain eight such views without any descriptive letterpress; but they are useful memoranda for the geologist or the visitor to bring away from this most picturesque portion of Dorsetshire. In the latter set is a pretty view of the Haggerstone, or Agglestone, as it is there spelt, a natural mass of rock, with no legitimate claim to the falsely given title of a Druidical remain.

The famous Lulworth Cove, Durlstone Head, and St. Alban's Head, are among the number of these well-selected views, which thus represent the scenic characters and physical geography of the Tertiaries, the Chalk, Portland Oolite, and Kimmeridge Clay, besides the Wealden and Purbeck beds.

The "Illustrated Guide to Swanage" contains more geological and other scientific information than we have ever seen in any work of so unpretending a character. The geological features of the district are undoubtedly worthy of such full notice, and the author has well pointed out the conciseness, so to speak, of the display within this limited area of many geological groups of strata. In a subsequent place the author points out the high commercial value of many of the mineral products of the locality described, the vast beds of fine pottery-clay, the fire-clay, the alum- and copperas-shales, pyrites and iron-ore, paving-, building-, cement-, lime-stones, and marble, the bituminous shales. so rich in gas and paraffine.

The natural divisions of the region are next given, attention being specially drawn to the two great hill-ranges of chalk and oolite, stretching nearly due west from Swanage Bay, dividing the tract into two upland and three valley districts; the chalk range forming the south-western extremity of the great basin of Hampshire and Sussex.

Mr. Beckle's excavations and researches, his discoveries of mammalian remains, the stone and marble quarries, from sixty to seventy in number, and other points of geological interest, are all successively noticed, and with sufficient accuracy to make the observations of value to the student, as well as to the general reader, or to the mere visitor.

The shelly-marble of this district is well known from its extensive use in ecclesiastical buildings of the Middle Ages, and Mr. Brannon's account of the Purbeck strata, and the rude manner in which the quarrying work is still carried on, will not only be of interest to our readers, but will afford a good example of the style of this very unassuming production:—

"The true Purbecks, or thin beds of shelly limestone, alternating with clays and sands, formerly considered as Wealden, now as upper oolite, furnish the great staple of the stone exports from this district. They consist of an immense number of beds from a quarter of an inch to four feet in thickness, mostly very hard and close grained, and separated from each other chiefly by beds of clay, varied with sandy and loamy, gravelly or marly earth. A very great proportion of the stone beds are useless, either on account of their excessive hardness, their friability, or softness. The upper beds are the well-known and beautiful Purbeck marble; beneath this, the thick beds of the harder kinds are adapted to sea-walls, fortifications, and other solid work, where minute cutting and rubbing are not required. The more easily worked, or 'freestone beds,' are used for all kinds of architectural dressings, external and internal stone-fittings, sunk and rounded work, such as sinks, troughs, granary and rick-leg and cap-stones, and in fact all those purposes where easy and clean cutting in work, and subsequent durability, are essential. The thin beds are employed for paving, and the stone when well selected is the best in the kingdom; the very thin layers of tough limestone, or the tough fissile beds, are split into suitable thicknesses as tilestones for roofing.

"All the useful beds are broken up by natural partings into blocks and slabs of various sizes, generally irregular rectangles, varying in size from ten or twelve feet long, by five to eight feet wide, down to eight or fifteen inches long, by six or ten inches wide, and three to eight inches thick. The latter class are termed pitchers, the term 'horse pitchers' being applied to the larger sizes. It is worthy of remark, that amongst the useless beds, those called '*hones*' by the workmen are the most frequent. The name is exceedingly appropriate, as both in the original mass, and in the smaller subdivisions, they have the smooth rubbed appearance of finished hones, or whetstones, as sold in shops. They are mostly argillaceous or cherty limestones, in their original mass appearing perfectly solid, without any indication of partings, but on being handled continually subdivide into rhombic pieces. But the most interesting to the stranger is the great 'Cinder'-bed, a blackish or brownish rock, with two or three subdivisions, consisting almost wholly of a small oyster-shell, the *Ostrea distorta*, and so exceedingly hard and intractable as to be almost useless, and only operated on by blasting. It would, however, be very serviceable for marine works, or for exposed batteries.

"The principal groups of beds of merchantable stone are termed *veins* by the quarriers. Describing them in descending order, we meet first with the *marble*, for ornamental purposes; then the *marble-rag* for walls; and the *lane-end*, or *laneing vein* beds, containing good stone for tomb-stones, paving, walling, and marine works. Below this is the *freestone-vein*, a group containing kerb-, step-, and tile-stone, and in its lower portion the admirably working and durable *freestone*, used for all kinds of cut and hollow work as above described. Below this, immediately above the great '*cinder*'*-bed*, is the *downs-vein* series, worked almost wholly for paving. Directly under the cinder is the *feather-vein* series, worked for steps, walls, and marine works, then below this the *new-vein* beds supply still larger slabs and blocks, for similar purposes.

"There is a freestone called *Purbeck bur*, exceedingly durable, yet very free to work, but the blocks are of small size. It was used for all the masonry of Corfe Castle, and the wonderful sharpness of the work there at the present time, almost without sign of decay, shows the value of the material. The quarries are not regularly worked, and are situated near Orchard, in Knowle parish. It belongs to the upper Purbeck strata.

"The quarries are all worked underground, and entered by oblique shafts, from twenty to a hundred feet deep; a slope for dragging up the stone, and steps at the side for the workmen, with a rude capstan worked by a horse at the top, and sheds adjoining, in which to carry on dressing the stone, constitute the whole arrangements in these primitive works. There are in the Isle of Purbeck about one hundred of these quarries, more than half being in the immediate neighbourhood of Swanage; it is difficult however to give the exact number, because there are constantly some being abandoned, or new ones opened.

"Below the true Purbecks is a great mass of clay-, sand-, and marl-beds, which however thin out towards the sea-cliffs, so that there the Purbeck limestones rest at once on the crest of the true upper oolite, or Portland limestone, and it is to the stone obtained from this latter formation within the Purbeck district, that the name of '*Purbeck*'*-Portland* is given. In the essential qualities of closeness, slight absorption, and durability, it excels the true 'Portland,' but these qualities, characterising the oolite increasingly in an easterly direction, are also accompanied by increased hardness, so that the fine quarries of Tilly Whim, and Howcombe, near the eastern extremity of Purbeck, have been long disused for dressed and hollow work on account of the labour involved, but for marine construction in *pierre perdue* the whole mass of Oolite there is admirably adapted. The other quarries in Purbeck furnish stone less hard than those above mentioned, but still superior to the true 'Portland' in their essential characters. All the quarries of 'Purbeck'-Portland are in the face of the sea cliffs, the first portion being cut down perpendicularly from the crest, which when effected at once by blasting is termed *ridding*, so as to form a platform level with the base of the merchantable stone, which in most of them is afterwards extracted by driving galleries into the rock, forming deep caverns, and leaving pillars for the support of the superincumbent mass. From the position of the quarries the produce can only be shipped in very calm weather, so that the greatest part of the year they are unapproachable.

"The beds, in descending order, are the '*cinder*,' the '*red-head*,' thick beds of shelly rock, the '*shrimp*'-stone, the '*blue-bed*,' the '*white*' and '*spangle-cap*,' good for lime, '*pond*' or '*upper freestone*,' a good material for building purposes, the '*cap-stone*' in three beds, '*listy*,' '*middle*,' and '*house cap*,' then the '*under-picking cap*,' which is picked or blown out to free the great bed of working stone, known as the '*freestone*' or '*under freestone*.' Below this is a thick mass of rock, containing large nodules of chert blending by concentric rings into the limestone. This has never been used, but would be admirable for the *pierre perdue* works, above referred to.

"The mode of shipping the stone from Swanage is even more primitive than that employed for bringing it to the surface. There is no pier for this purpose, although its construction would be a source of great profit even in the present state of the trade. The stone, being carted to the beach, is there piled on the bankers, as the storage quays are called; when wanted it is handed into a cart, the cart is drawn into the water, and the stone is passed into a barge, and thence again is delivered to the vessel lying in the bay. For the oolite, or 'Purbeck'-Portland, it is necessary to get it from the quarry in the short intervals of fine weather, when it is craned into the vessel and conveyed to the bankers, where it remains until it is required for use. By these cumbrous arrangements a valuable and beautiful piece of beach is rendered a useless deformity for all other purposes, and by this accumulation of tedious and expensive labour, some of the finest and most durable building stones are prevented from being so fully employed as they might be, and a great hindrance is created to the execution of architectural works, for which the varieties of Purbeck and 'Purbeck'-Portland are not only eminently fitted, but really superior to any other kinds in the market."

Geological Map of England and Wales. By A. C. RAMSAY, F.R.S. F.G.S. Local Director of the Geological Survey of Great Britain. London: E. Stanford, Charing Cross.

WHEN we say this is unquestionably the best geological map as yet published of England and Wales,[*] we have said all that even Professor Ramsay could desire of a critic, and we may fairly proceed to point out what appear to be defects. This we do unactuated by the slightest desire to find fault, but simply because an authoritative name will often lend an unintentional character to blemishes.

First, then, in more places than are indicated on this map the occurrence of alluvium might have been marked; as, for instance, the Pevensey levels, on the north side of the mouth of the Humber, and in the river valleys of Norfolk.

The patch of Tertiary strata at Newhaven has been overlooked, and we should have certainly wished that Professor Ramsay had dropped as obsolete the term "Plastic Clay;" for having partly adopted Mr. Prestwich's admirable grouping of the British Tertiary strata, he should also have adopted Mr. Prestwich's far preferable denomination of "Woolwich-beds."

---

[*] We are not oblivious of Mr. Greenough's long celebrated map, the larger size of which gives, of course, greater latitude for details. A new edition of this, we believe, is about to be published. Its greater dimensions and higher pretensions will necessarily make it a more expensive work; but although it should even surpass Mr. Stanford's publication, it can never be regarded in the light of a rival.

The Purbeck beds are left out in Section No. 1, on one side of the curve at its rise at the foot of the Downs, near Watlington. Lundy Island, too, is nearly all granite, if we mistake not, and is therefore wrongly coloured, although it appears to have the correct indication-letter. The reference number 23 is left out on the outliers of typical Bagshot-sands, and this is of moment, as the tint is so like those of the Upper Eocene and of the Alluvium (24 and 26), that the reference number there is of great value.

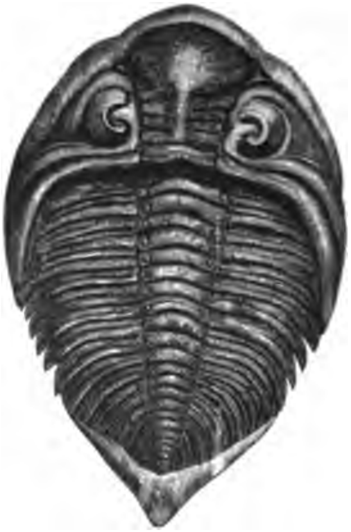
We have long observed a great looseness of diction and of phraseology in numerous geological works. We have noticed it with regret, in more than one writer, even amongst the really talented staff at the Jermyn Street Museum. The yielding to such looseness of language, and, still worse, the actual adoption of a particular geological slang, has crept into vogue far too generally amongst geologists, for the reviewer to pass either without comment in his remarks upon any really good or popular work. The strongest censure of Mr. Toulmin Smith's condemnation of geologic jargon may be far more justly applied to such instances of carelessness than to the generally useful although sometimes barbarous combination of Greek and Latin words, or to a few facetious corruptions of personal names as generic or specific designations.

It is, however, only to a very modified form of such looseness of expression, or rather perhaps it is to merely an official disregard of the true meaning of words, that we allude in the present case. It is to the use of the word "lime" for limestone, in diagram No. 6. Again, in Lower Lias clay and "lime," in section No. 2; Wenlock "lime," in No. 5, &c. Now, limestone is not lime, and lime does not exist in nature as such, but only in combination with some other substance, such as carbonic acid gas, when it is a carbonate of lime or a limestone; or with sulphuric acid, when it is sulphate of lime or gypsum. In no case whatever on this map ought there to be written "lime."

We have a high respect for Professor Ramsay, and we have the pleasure, moreover, of enjoying his friendship; our stronger remarks, therefore, are not intended to apply to him individually, but to attack the outgrowth of a vile system, which has already disfigured some of our best geological books and works, and the tendency of which is to reduce to worse than newspaper style that which ought to be of strictly classical composition.

Some contracted expressions occurring in the flowing passages of a description are often susceptible of a ridiculous interpretation. In reading, some time since, a book by another author, we came upon the following passage:—"I well remember, many years ago, being *struck*, when attempting to walk under the cliffs from Scarborough to Filey Bay, *with the enormous slices* or square pilasters of cliff, that, having been undermined by the action of the breakers at high-water, had fallen forwards," &c. We could not, at first, help sympathising with the unfortunate author, and had half ejaculated an expression of hope that he had not been seriously hurt in his dangerous journey, when we perceived from the context that he had not really been injured or even hit, but that he had been merely mentally struck with the *appearance* of those singular masses referred to.

To return again to Professor Ramsay's excellent Map, for we would not willingly conclude our notice of it with any other expression than that of the well-merited praise it deserves, we would add, that we have observed the more correct delineations of the geological features of particular districts, beyond even what has been accomplished in the Government Survey sheets themselves, issued, it is true, some time since. We can, however, but be grateful for the communication of the new information which Professor Ramsay's personal knowledge of the labours of the official staff subsequent to the publication of those documents has enabled him to give us; and while cautioning the inexperienced that the admirable sections attached to the present Map are constructed chiefly from the measurement of the angles of the dip of the strata at their outcrops, and that consequently they are often highly hypothetical, as far as the underground continuation of the beds is concerned, we would praise this successful effort to teach, by means of the eye, some highly important passages in the geological history of our island.



PHACOPS CAUDATUS.—From the Limestone of Dudley.

In the Private Collection of Professor J. Tennant, F.G.S.

THE GEOLOGIST.

APRIL, 1859.

ON THE STRUCTURES PRODUCED BY THE CURRENTS PRESENT DURING THE DEPOSITION OF STRATIFIED ROCKS.

By H. C. SORBY, ESQ., F.R.S., F.G.S., ETC.

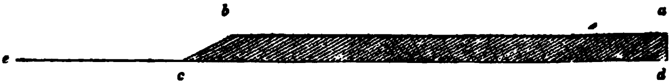
IT is now several years since I first became convinced that a diligent study of the various structures produced by the action of the currents present during the formation of stratified rocks would lead to the knowledge of many very valuable and remarkable facts in connexion with physical geology and ancient physical geography. Since then I have never willingly lost any opportunity of determining the direction and character of the currents present during the deposition of rocks of every age, and of accumulating information on every kind of subject that could throw light upon the inquiry. I must now have, in my note-books, not less than twenty thousand recorded observations, many of which I have not been able to make use of hitherto, for want of sufficient points of comparison; and, although I am most willing to admit that the subject is quite in its infancy, and that I am a mere student of nature, ready to modify my own opinions or to adopt others which would explain the facts in a more satisfactory manner, yet some of the facts are so definite and distinct, and I have verified them in so many localities, over sufficiently extensive districts, as to warrant the formation of definite conclusions. We all protest against theories without facts; but to accumulate a great number of facts without attempting such explanations as would unite them into a complete and consistent whole would be not less unphilosophical.

In various papers in the "Edinburgh New Philosophical Journal" (new series, vol. iii. p. 112; iv. p. 317; v. p. 275; and vii. p. 226) I have explained many of my deductions, and I have shown that many peculiarities of physical geography at former epochs may be learned from a knowledge of the directions of the currents in various localities. In those papers I entered into some portions of the subject at greater length than would be proper on the present occasion, when I shall attempt to give a general popular outline of the whole, referring the reader to those papers for more special information. I have often felt surprised that scarcely anyone has entered into this field of inquiry, in which the facts are so marked and distinct. If the current structures had been on a small scale requiring the aid of a microscope, there would have been good reason for this; but such is not the case; although I find that, from some extraordinary misunderstanding, many persons have imagined that it is so. Unassisted eyes and a compass are all that are requisite in determining the greater number of the facts, and I have never before said that the microscope is not required ,because I never thought anyone would imagine that it was. Moreover, many of the structures have been known long enough, for they are of such a character that no one could overlook them, although sufficient attention may not have been paid to their teachings; and the study of their relation to one another and to other facts in an accurate and business-like manner may have been neglected.

If advantage be taken of an artificial water-course, or of natural streams of water, to examine the effect of the current in the deposition of sand, it is easy to see that, according to the circumstances of the case, three very different kinds of structure are formed, from which the direction of the currents could easily be ascertained. If the bottom be tolerably level, and the velocity of the current just sufficient to drift forward particles of sand, a kind of grained or striped surface is almost always produced. The variable motion of the water along a particular line marks that line on the surface of the sand, in elongated patches of various colour and character, so distinctly that, even when the current has ceased, or the water has been dried up, we can clearly perceive the direction in which the current moved. If some of the sand thus drifted forward accumulate at the bottom, of course an horizontally stratified mass would result, each layer of which would have a grained and striped surface. Sandstones of this character, which may be distinguished by the term "grained or striped horizontal stratification," are very common in the lower coal-strata; and they are so distinctly grained and striped that there is no difficulty whatever in determining with certainty the *line* in which the ancient current moved, while the side from which the current came can usually be learned from other structures.

If in a modern water-course the depth of the water increase to such an extent that the velocity of the current is diminished so much that it becomes too slow to wash the sand forward, the sand is then transported only to a certain point, where it falls down and accumulates on a slope. This will be best understood from the following diagram (fig. 1)—

Fig. 1.



representing, by a vertical section in the line of the current, what takes place at the bottom of the water. This kind of structure can only be formed where there are particular relations between the depth of the water and the velocity of the current. The velocity above the part *a b* must be sufficient to drift forward the sand when the sand is in motion, or else there would be no increase in the dimensions of the bed for lack of material carried forward and thrown down at *b c*; but the velocity must not be so great as to wash up the sand from a state of rest along the surface *a b*, else the bed would not remain permanent. As might be expected, there cannot be a great difference in the velocity of the currents producing these different effects; but still it is easy to convince one's-self by experiment that there is a decided difference. In one case the velocity need be only sufficient to cause the resistance offered by grains of sand to the motion of the water to be rather more than equal to the mere friction of the transported sand on that lying unmoved at the bottom; whereas, in the other case, it must be enough to likewise overcome the inertia of the grains of sand. Above the part *c e*, the velocity must be so much less than above *a b* that the sand can be left at *b c*, and not drifted forward beyond *c*. When such is the relative velocity of the current before and after arriving at *b*, the particles of sand are drifted along the bottom from *a* to *b*, and thrown down on the slope *b c* at an angle of from 30° to 40°, varying according to the character of the material. We may often see beds of this kind in the process of being formed in rivers and water-courses, and can clearly perceive that the current must come from the opposite quarter to that towards which the beds parallel to *b c* dip. When the water is all dried up, and especially in frosty weather, when the otherwise loose sand is consolidated with ice, it is easy, by cutting into small beds of this kind of structure, to see the smaller bands of varying colour and character parallel to *b c*, represented by the lines in fig. 1, and to perceive that it is identical with much of the so-called "false-bedding." Since, however, some false-bedding has been produced in a very different manner, it is desirable to distinguish that just described by a special name, and I have therefore employed the term "drift-bedding," in allusion to its being formed by the drifting forward of the material, and to its being so pre-eminently characteristic of deposits drifted into their present resting-places, and not in anywise deposited from above, as in the case of other kinds of stratification. False stratification may also have been produced under a variety of circumstances, differing from those just described; but in many cases, as when, for instance, a single bed, as in fig. 1, extends with uniform thickness and character for several hundred yards, all other explanations are out of question.

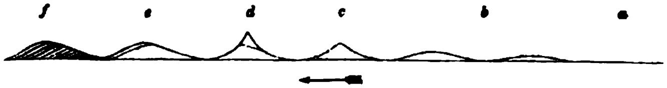
Strictly speaking, perfectly developed drift-bedding and simple horizontal stratification are two extreme structures which gradually pass into each other. In drift-bedding the material is drifted forward along the bottom *a b*, and thrown down on *b c*, whilst none is deposited on *a b* or *c e*. On the contrary, where simple horizontal stratification is formed, none is washed forward along the bottom, but all is deposited from above, more or less uniformly, from *a* to *e*. The connecting link between these is the "grained and striped stratification." In passing into this, the angle *b c d* becomes gradually less, the velocity of the current above *a b* and *c e* becomes more and more nearly equal, the sand is drifted over the face of the inclined plane *b c*, causing it to be grained and striped, and some is even carried forward and deposited beyond *c*; and when the angle *b c d* becomes very small, or of no appreciable magnitude, the whole passes into the horizontal grained and striped stratification. This, again, by the increase in the amount of the material actually deposited from above, and the decrease of that drifted forward, passes into simple horizontal stratification, with little or nothing to indicate the direction of the very feeble current. The production of the grained and striped, instead of the simple horizontal stratification, therefore, depends upon the actual velocity of the current; whilst the formation of drift-bedding depends upon the relative velocity above *a b* and *c e*, which must usually be in inverse proportion, to the relative depth. The thickness and other characters of the bed must therefore be so intimately related to the actual depth of the water, that, when all the requisite data have been determined, this actual depth could be calculated from the thickness and peculiar characters of the bed *a d*.

I have already made a number of experiments from which a first approximation to this very interesting problem can be deduced; but, before everything can be determined in a perfectly satisfactory manner, it will be necessary to take into consideration many things requiring much further investigation. Even in the present state of the inquiry, however, we may draw several important conclusions. The existence of perfectly similar beds, separated by a considerable thickness of rock, clearly shows that, whatever the actual depth of water might have been, it must have been the same at both periods, which, of course, necessitates the notion of a considerable amount of subsidence having taken place; whilst, in other cases, the upper beds indicate a less depth than the lower, as if owing to a decrease in the depth of water, caused by the accumulation of the deposits.

We all know very well that when wind blows over the surface of water it gives rise to ripples and small waves, which trend perpendicular to the direction of the wind, and move forward in the line of its motion. We could thus readily determine the direction of the wind from the direction of the waves and ripples on the surface of the water. In a somewhat similar manner, when a current of water moves over sand and water, small wave-like undulations are generated on the surface of the semi-fluid mixture of sand and water, of which the bottom consists. The nature of the material of which these waves are formed is such, that, when the current ceases, their forms remain, and thus permanently record the direction of the current, which, of course, must have flowed in a line perpendicular to their trend. These wave-like forms are the well-known "ripple-marks," about the origin and nature of which there has often been much misunderstanding. They have too frequently been looked upon as having been invariably formed by the action of the waves of the surface of the water stranding on a sandy beach. They are, however, by no means necessarily connected with the waves of the upper surface, but are merely the effect of the movement of the current over the sand, and are the impressions of disturbances of a wave-like form affecting the bottom of the current, and generated by the resistance experienced by it in moving over the sand, under certain conditions of depth and velocity. Stranding waves produce "ripple-marks" on a sandy beach, because they give rise to a current; and it is this current which produces the ripple-marks. Other facts must be taken into account, if we wish to decide whether any particular ripple-marks were formed by wave-currents, or by currents due to any other cause.

If we have merely the surfaces of the ripple-marks to guide us, we cannot always determine from which side the current came; but very commonly their wave-forms move forward and progress in the same direction as the current of water which generates them. This is owing to the sandy material drifted forward by the current being carried up the side of the ripple turned towards the direction from which the current comes, and then thrown down on the opposite side more protected from the action of the current. This will be more clearly understood by means of the diagrammatic section, fig. 2, which

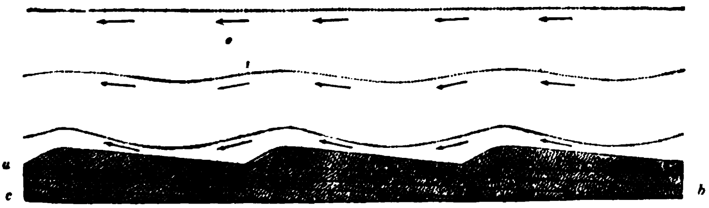
Fig. 2.



is intended to show the connexion and gradual passage from a level surface at *a*, to low and round-topped ripples at *b*, which at *c* and *d* become crested and sharp-topped. Except in rare cases such a ripple as *d* could not hold together; the upper portion would be washed off, as far as the dotted line, by the current (supposed to be moving in the direction indicated by the arrow), and the material thrown down on the protected side, in a small bed, as at *e*. Sand is usually also washed up by the current from the exposed side of the ripple, and thrown down on the protected side; so that ripples like *f* gradually progress. In this case it is very easy to ascertain the direction from which the current came; for, of course, it must have flowed in a line perpendicular to the trend of the ripples, and from the opposite side to that towards which the small beds of the ripple dip, as shown by the arrow in fig. 2.

If no actual deposition be taking place, and there be merely a drifting forward of sand along the bottom, when the ripples progress there is necessarily as much washed up from one side of each ripple as is thrown down on the other; and, therefore, nothing but an advancing series of laminated ripples is formed. If, however, more sand be deposited than is washed up, so that there is an actual accumulation of material, the lower part of the advancing ripples is necessarily left behind. Fig. 3 will make my meaning apparent, and represent in section that which occurs when deposition takes place at a uniform rate. For all structures that are the effect of the action of ripples on drifted material, I have employed the term "ripple-drift." This necessarily includes some cases of the well-known ripple-marks, which term I would, however, restrict to those instances where the upper surfaces of the ripples are more or less perfectly preserved. When this is not the case, the resulting structure might easily be confounded with "drift-bedding," and no doubt often has been classed with it as "false-bedding," being much more like it than like ripple-marks. It will much facilitate my explanations if we also adopt the following descriptive terms, and call the whole thickness, *a c*, a "bed"

Fig. 3.



of ripple-drift. The layers parallel to *a b* may be called the "ripple-drift-bands;" whilst the smaller layers of which these are composed may be distinguished by the term "stratula." The thickness of the beds, the length of the bands, and the number of the stratula, may be indefinite, whilst their other peculiarities are definitely related to the circumstances under which each bed was formed.

The "ripple-drift-bands" are the lower portions of the laminated ripples of the upper surface, which were not washed up, but covered over by the next-following ripples advancing over them. They are, therefore, made up of oblique bedded stratula, and in this respect resemble a single bed of drift-bedding; but, from the nature of the case, they are inclined to the true plane of horizontal stratification at the angle *a b c*; whereas a single bed of drift-bedding is parallel to it. They also usually differ much in size. I have seen beds of drift-bedding twenty-five feet in thickness, and beds several feet thick are very common, whereas the thickness of an inch or two is considerable for the "ripple-drift-bands." Still, in some cases, the size is quite similar, and then it requires care to distinguish a band of "ripple-drift" from a bed of "drift-bedding," notwithstanding that they differ so essentially in their origin and relationships.

If anyone will reflect on the manner in which the "ripple-drift-bands" are formed, he will perceive at once that their thickness indicates the excess of material deposited on the sheltered side of the ripples over that washed up again from the exposed side, during the time required for each ripple to advance a distance equal to its own length, which time we may conveniently call its "period." The thickness of the bands, therefore, shows how much material was permanently accumulated during the period of the ripples, which must be a portion of time so definitely connected with the structure and character of the ripples that I feel persuaded we shall ultimately be able to deduce from them the actual period for any given instance, and thus, knowing how much was permanently deposited in a given time, we should know the *rate* at which deposition took place. Hitherto I have made so few trustworthy experiments on this point, that I do not profess to be in a position to solve this problem with approximate accuracy, but even now we can form a good opinion respecting the relative rate of deposition, and can perceive that this relative rate must have varied much. In some cases, no permanent accumulation can have taken place; for simple ripple-waves advanced leaving no bands behind them; whereas, in other cases, deposition must have gone on at a very considerable rate, for the greater part of their material must have been left behind in the form of thick bands. Sometimes the rate of deposition must have been very uniform, as indicated by the uniform thickness of each band; whilst still more commonly the rate must have been very variable, for the thickness of each band varies very much in different parts.

The actual velocity of the current is of course very distinctly indicated by the character of the materials of which either drift-bedded or ripple-drifted layers are composed; but it is probably also related to other peculiarities in their structure. There are several curious facts still unexplained; but I am much inclined to believe that the velocity of the current has a considerable share in determining the length of the ripples. I have seen cases where the separate ripples were not an inch apart, and others upwards of a yard from each other; and there must have been some definite cause, more or less intimately connected with the depth and velocity of the current, for this difference.

Such, then, is a general account of the conclusions to which I have been led by the study of the structures produced by the action of currents. These various structures are so common that they cannot have escaped the attention of anyone who has carefully examined stratified rocks. Nevertheless, it must be admitted that scarcely anyone has studied them as they ought to be studied, or attempted to draw from them the important conclusions to which they lead. A comparison of what may be seen in progress in modern currents of water with the structure of deposits formed at earlier epochs, is sufficient to convince anyone that the mere direction of the current can be readily determined in those cases in which its velocity was sufficient to have any decided effect. This alone enables us to ascertain many very important particulars respecting the formation of stratified rocks. It points out the quarter from whence their materials were drifted, and also many of the peculiar features of the physical geography of the period, as I hope to be able to show in a subsequent communication. But this is not all; for, when strata are deposited under the influence of a current, the character of the resulting structure must depend upon the depth of the water, the velocity of the current, the nature of the deposits, and the rate of deposition. Now, I argue that all these are more or less intimately concerned in the production of every bed of rock, and that the various structures which I have described are so related to them by definite and unalterable physical laws, that, in many cases, the whole secret of its formation is locked up and preserved for our information, if we will but perseveringly search for the key. At one time no one would have thought it possible to ascertain the nature and habits of an extinct animal from the examination of a few bones or teeth; but Palæontology has now been so perseveringly elaborated by able investigators that we look upon this as a matter of course. The laws of the organic world are surely no more definite and exact than those of mechanics and hydrodynamics involved in the formation of stratified rocks, that geologists should place full confidence in one and so far neglect the other as too often to fear to attempt to deduce from them equally definite and exact conclusions. The problems may appear to be more difficult, and their solution may, and certainly does, require a very different kind of study and train of thought; but that is no reason why its solution should not be attempted. My opinion is, that the various structures which I have described are so intimately connected with the circumstances under which they were formed, that nothing but perseverance is required to enable us to determine the depth and velocity of the current, and the rate of deposition, with more or less accuracy, from the existing peculiarities of ancient stratified rocks. If there be only an apparent probability of doing this, it is surely better to make the attempt and fail than to be content with our present ignorance and to make no effort at all. Even at present the facts are sufficiently distinct to enable us to form tolerably satisfactory conclusions respecting the relative depth and velocity of the current and the rate of deposition, and to perceive that the knowledge of their actual value would enable us to make a very great advance in physical geology. For this purpose many experiments will be requisite, which I hope I shall be able to make, and which I should have made before now if I had not been induced to follow out other inquiries involved the study of the structure and origin of rocks. Those which I have made already, though not nearly sufficient to clear up many highly important questions, are still sufficient to give very great encouragement; and I therefore feel anxious to induce others to turn their attention to this branch of research, being convinced that it cannot but yield a bountiful harvest of facts, when studied with perseverance and zeal.

ON THE FLAGSTONES OF FORFARSHIRE.

By HUGH MITCHELL, of Craig.

THERE is a close resemblance between the fossil contents of the "Upper Ludlow Tilestones," as described by Mr. Roberts, of Kidderminster, in the last number of THE GEOLOGIST, and those of certain strata developed in this neighbourhood. The rocks of the southern districts of Forfarshire have been described by Fleming and Miller, and their fossils have attracted the attention of the scientific world. I am acquainted with sections in the north-eastern division, an account of which has not yet appeared in print, and it may be of interest to indicate their organisms.

Among our fish-remains I have twice met with heads of the *Cephalaspis Lyellii;* but the fossil is more common in other localities. The Pteraspides, which seem to be so frequent in the English beds, I do not know, unless some of the fragmentary remains, like pieces of skin or shell, and to which I shall hereafter refer, belong to the genus. From one of our sections I have collected several specimens of at least two species of fishes, entire and beautifully preserved. They are small creatures, and have all their fins armed with spines. One of my specimens is a very tiny fish, scarce an inch in length, but with its every spine in its place, and, so far as regards its dermal covering, a complete picture. We have also a considerable variety of Ichthyodorulites. Some of them resemble the Onchus-spines figured in the first edition of Sir Roderick Murchison's "Siluria." Others are larger and have more the appearance of true fish-defences. Mostly all our fossils are mere impressions in the stone; but the bony matter of the

Ichthyodorulite seems occasionally preserved, and there are also other indeterminate fragments of bone.

Not having had access to Mr. Salter's monograph, I am not able to pronounce upon the species of crustaceans found in these beds. We have at least several very large Pterygoti, judging from the sculptured rings of the abdomen, their curious jaw-feet and prehensile limbs; and I should think both *Himantopterus* and *Eurypterus*. I have carefully treasured all the crustacean remains that I have found, in the hope of light yet reaching us in this remote region as to their generic and specific character. All that I can affirm is, that we must have had an abundant development of the family in the era when our rocks were laid down, of all sizes, from half an inch to many feet, and with various styles of ornamentation. There also occur numerous pieces of shell or skin, sometimes torn, but at other times bounded by straight lines, drawn in black in the stone, and which an humble friend of mine compared to the pieces—of course, in miniature—of which a black cloth coat on the back of a human subject is composed. We must not omit to mention a very peculiar form, which has been named the *Kampecaris*, from its resembling the impression in the stone of a butterfly-caterpillar, and which I have often thought might be the larval form of some of our crustaceans.

Our plant-remains, like those of Kidderminster, are for the most part badly preserved, although in some layers they are very abundant. Our most common and characteristic organism is the *Parka decipiens*, which, occurring over three counties in Scotland, viz. Kincardine, Forfar, and Fifeshire, has now also been detected in England. I do not know on what ground it can be spoken of as Pterygotean ova. It is true, our quarrymen, in their rude northern phrase, call it "puddock crud," or the spawn of frogs, but they are chiefly familiar with the fossil as it occurs in the more micaceous beds, known in commerce as "Arbroath pavement," where it is always much broken and dispersed. I still believe it to be vegetable. I have several specimens with the seeds (?) inclosed in a sort of spathe, the sides of which radiate from a base or disc, to which is attached apparently a stem. There are also several distinct bodies which might correspond with the spores of *Lycopodiaceæ*, besides many other obscure vegetable

n the whole, therefore, there is a striking similarity between our fossils and those of the "Upper Ludlow Tilestones," if, indeed, they are not identical. Hugh Miller, in his classic work, the "Old Red Sandstone," assigned our Forfarshire strata to a middle formation of the Old Red or Devonian system. Murchison, on the other hand, places our "Cephalaspis-beds" at the base of the system; and the fossil evidence which I have briefly related seems to decide in favour of the latter view. This point is of great value in the arrangement of our rocks, as in the grits and conglomerates, and even in the underlying and highly metamorphosed slate-rocks, we are to recognise the equivalents of the Silurian system as known in the south of Scotland, or better still in Shropshire and Wales.

So far as I know, no fossil has been disentombed in this part of the country from any strata beneath the flagstones; but perhaps the discovery, some day, of a graptolite or other characteristic Silurian organism will reward the researches of the geologist along the flanks of the Grampians.

ON THE TILESTONES OF FORFARSHIRE.

By JOHN ANDERSON, D.D., F.G.S., ETC.

THE March number of THE GEOLOGIST contains, I observe, a notice of the "Upper Ludlow Tilestones," and the author invites descriptions of their equivalent beds in other districts. Now, so close are the resemblances, lithologically and palæontologically, between these deposits and those of Forfarshire, that they may be regarded as part of one and the same series. I have been induced, therefore, to throw together the following observations upon our northern Scottish system.

The rocks to which I refer occupy a narrow but extended trough-line along the central district of Forfarshire, commencing on the east near Montrose, and terminating at Babruddery and Rossie Den on the west. They trend in a south-westerly direction, across the river Tay, into Fifeshire at Parkhill, Newburgh, and along the northern slope of the Ochils towards Dunning and Tereagles in Perthshire. These tilestones, and the grey and red sandstones with which they are systematically associated, occupy the whole superficies of that well-known and beautiful tract of country which is bounded by the old crystalline rocks of the Grampians on the north, and by the later felspathic Ochil range on the south; and it includes the celebrated geological localities of Cavonylie, Glammis, Forfar, Kinnordie, Clashbennie, Babruddery, and Parkhill.

The strata all dip off from the Grampians, generally in a south-easterly direction, and at various degrees of inclination. They rest on a great coarse foundation of conglomerate, the true equivalent of the fundamental conglomerates of Caithness and Sutherland; and thus they constitute, with the absence of some members of the series, component parts of the Lower Division of the old red sandstone. The thickness of the group may be estimated at about two thousand feet, the deepest section of which is exposed in the quarries of Balbeuchlie, and which, uptilted at various angles, protrudes along the ridges and numerous valleys of the highest crest of the Sidlaws. There are, in the line of strike from north to south, two well-defined synclines and three anticlines, occasioned by the upheaval of the trappean formations.

A new opening was lately made into the tilestone-beds at Tealing; and, as it has proved so exuberantly rich in fossil remains, I shall confine the few observations I have now to make to this most interesting locality. I visited the spot in February last, in company with Lord and Lady Kinnaird, Sir John and Lady Jane Ogilvy, and an enthusiastic party of juveniles of both sexes, some just fresh from their Oxford studies.

The fossiliferous bed of "Tilestone" rests upon bands of highly micaceous flagstones, the well-known "Carmylie pavement," and is overlaid by strata of similar lithological structure and mineral constituents. The ripple-marked bands are above as well as below, and the tilestone itself is often deeply indented by the wavelets. The distinguishing characteristics of the tilestone consist in its finer texture, more fissile lamination, and deep blue colour,—which often render it, in hand specimens, difficult to be distinguished from the old clay-slate.

The space cleared at the Coral Den of Tealing, on the day in question, was about ten feet square, every patch of which contained fossil markings of some kind or other. The *Parka decipiens*[*] was the most conspicuous, colouring the whole face of the rock, a perfect Pterygotean egg-nest inclosed in its sedgy mass of vegetation. As a proof of the denseness of this ancient spawn-bed, in the restored ova of the creature, suffice it to state, that on a portion of the rock now before me, seven inches by five, I enumerate seventy to eighty distinct impressions of the egg-sac. Some flags, two to three feet square, had the whole surface blackened and reticulated with the eggs and pedicles of the oviparous organs. The impressions are generally rounded, and of all sizes, varying from that of a garden-pea to upwards of an inch in diameter; some of them, indeed, two inches by an inch and a half in length and breadth. The inclosing sac, in some cases, is entire and opaque, showing no portion of the developed eggs or dots; in other cases, the vessel appears to be bursting, and part of the ova are visible; while again, in others, the whole clusters are complete, and in their fullest development for the inspection of the microscopist.

A locality so affluent in the spawn—if spawn they really be—could not fail to present evidences of the depositor of these curious organisms. Tracings accordingly of the huge crustacean were everywhere abundant. The mandibular feet, or jaw-feet, of the Pterygotus turned up, more or less perfect, on almost every flag. Several of the broad plates that envelope the body were likewise found; as also some good specimens of other parts of the carapace. A large swimming-foot was among the trophies of the day. But no entire fish, the eager object of search, rose to the captivating beat of the hammer, although we trawled the identical spot where was bagged the splendid specimen exhibited at the Leeds meeting in September last; and, what was the more stimulating to our labours, we were assisted by the same James McNicol who was the finder of the fish, and who still possesses among his geological stores the upper concave cast of the creature, and with which neither coaxing nor bribe will induce him to part.

---

[*] The probable relationships of the so-called *Parka decipiens* may be—

1. (??) A real fruit like a blackberry, as remarked by the first observers.
2. (?) The fruit of the sedges which Dr. Anderson says are so plentiful;
3. (??) The spawn of frog-like beasts,
4. (??) The spawn of newt-like creatures, to both of which Dr. Mantell has referred.
5. (?) The spawn of Pterygotus, as it is considered by Page and Salter.

For information on these points see Dr. Mantell's paper in the Quart. Journ. Geolog. Soc., vol. viii. p. 106, Lyell's "Manual of Geology," Murchison's "Siluria," Page's "Advanced Text-book of Geology," and "The Wonders of Geology" (Mr. Rupert Jones' edition).—Ed. Geol.

Mr. James McNicol, now that I have introduced him to the reader, is "grieve" at Tealing Manor, and will be found a most useful guide and intelligent explorer in the quarries of the district. These lie nearly equidistant from Dundee and Forfar, about eight miles inland from each; and, as both places are on the lines of railway to Aberdeen, the *savans* of the ensuing meeting of the British Association will command an easy opportunity of paying them a visit.

But, in addition to the interesting fossils enumerated above, the party were equally successful in their capture of various other organisms. Rich as the bed of tilestone is in *Parka decipiens* and limbs of *Pterygotus*, there are spines and other osseous fragments in the greatest profusion. The spine-forms, indeed, are so numerous that in some parts the surface was literally covered with them; the white spear-like projections contrasting strongly with the fucoid masses in which they were entangled. There were likewise fragments of bodies resembling the recently detected *Ceratiocaris* and *Kampecaris*, and undoubtedly a caudal appendage of *Stylonurus Powriensis*, so abundant in the quarries nearer Forfar; and along with these were some well-defined heads of the *Cephalaspis Lyellii*.

The plant-remains are equally abundant, consisting of stems and branches of trees, and tufts of water-grasses thickly matted together. The stems are generally flattened, often three to four inches broad, but the bark is so changed by carbonization as to render the application of the microscope of little use. The sedge-like grasses (*Juncites*) are slender and jointed, and sometimes several feet in length. For miles east and west, in every opening of the tilestone-bands, the surface of the rock is entirely blackened by these and the other organisms, clearly demonstrating a quiet inland shore-line, or marshy lagoon, over which much of the detritus may have been cast by the action of the tides, and in the silt of which such may have flourished *in situ*. Thither would roam the Pterygotus, Cephalaspis, and other fish and crustaceans in quest of food, so plentifully supplied by the shrimps, grubs, and other small creatures that lived in the shallows, or there sought a fitting place for the deposition of their spawn among the seaweeds of the period.

One other specimen more, of vegetable-like matter, I shall just notice as falling under observation that day. The forms of this substance have a spongy appearance, are of a deep red ferruginous colour, extend laterally in the rock several yards, and descend vertically into the matrix about a foot to a foot and a half. Mr. Salter's attention has been called to this curious concretion, and a specimen, three yards in length, is now under examination in Jermyn Street.

THE COMMON FOSSILS OF THE BRITISH ROCKS.

By S. J. Mackie, F.G.S., F.S.A., etc.

(Continued from Vol. I. page 289.)

Chap. 3. *The Remnants of the First Life-World, and the Bottom-rocks.*

In one of my last papers on the "Bottom-rocks" I appended a coloured map to a portion of the first dry-land of our mother-earth, a portion of the first division of the land from those waters "which covered the globe," a fraction of one of those primeval cracks or ridges which then remotely shadowed out our present continents and oceans; and in the little green patches I gave all the traces known of the first beaches and sands which spread around those low and barren tracts in the great region of North America which I selected for an illustration. To this map I hope soon to add, as supplements, others of South America and of Europe. Africa must be left yet a long while ere one dare make the like attempt. To these maps, from time to time, I shall add colour after colour to show the successive deposition of those great rock-formations in which the animals and plants of the successive life-creations of our planet have been entombed; and I hope also to be able to give charts of the teeming oceans during each of those past wonderful ages severally characterised as the stages of progress and development of organic beings. If we regard the outlines of those primitive land-domes and crests when laid down upon a map of the world, we are struck with their simplicity. We may remark, too, their frequent concurrence with those lines of greatest heights which abut against the oceans of greatest extent. The highest mountains of the land face the heaviest waves of the sea. The lines of igneous and volcanic products in all ages have been, and still are, the barriers to the sea's most powerful labours; the lavas and granites fused in the subterranean depths have been evolved to form an unconquerable wall against the most destructive powers of the foaming waves. A towering chain borders the Pacific from Russian America to Tierra del Fuego: lower hills face the narrower Atlantic; but against the smaller Arctic Sea no special mountain-land is presented.

While those lines of primeval uplift determined the directions of the mountain-ranges and thus established the basis of the subsequent continental areas in the accumulated sediments successively deposited on their protected flanks, so the great parallel lines of subsidence and depression gave the form and direction to the profound abysses of the deeps and ocean-basins.

America thus presents almost the simplicity of a single continuous result compared with Europe, which is full of complexities.

We have said against the greatest oceans there is the highest land. Throughout all known time this has been the rule: for wherever the sediments have been most thickly deposited, *there* has taken place the greatest uplifts. Nature always works by positive laws, and there is some reason for this. We are not very partial to the doctrine of a *central* incandescence; we admit, however, most entirely, the existence of a deep-seated internal heat, of, even now, very great intensity. There are certain lines of equal temperature in the subterranean portions of the earth's crust. There is such a line, for instance, of temperature equal to that of boiling water. Now this subterranean isothermal line would not be continuous at one even depth all round the circumference of this planet; but it would vary in its depth from, and in its approach towards, the surface, according to the density of the rock-materials, the free circulation of water, and many other natural causes; so that this, as well as every other such isothermal line, would in any given vertical section present the form of an irregular undulating curve.

Now wherever the deep oceans reposed, their water-masses would form natural conductors of the internal heat, and beneath them the lines of equal heat would recede more or less towards the centre. But wherever great quantities of sediment were deposited, there the conducting power of the ocean-water would be prevented from action, and the isothermal lines below would ascend. Thus such deposits of sand and mud would be exposed to the force of the subterranean heat; and these new strata, if of limestone or other similarly heat-affected substances, would expand; and the result would be an elevation of territory. Thus, in North America, the great uplifted mass of the Alleghanies (Apalachian Mountains) consists of Paleozoic sediments; or, in other words, that uplift or elevation was of post-Carboniferous date. The Pyrenees, again, are of post-Cretaceous elevation; the Andes of South America, the Alps in Europe, and the Himalayas of India are of post-Tertiary, or, more accurately, of post-Eocene date.

If, on the other hand, the accumulated sediments subjected to the action of the internal heat by the subterranean rise of the isothermal lines were of aluminous or other similarly heat-affected mineral material, a contraction might take place; and, instead of an uplift, an extended depression, deepening the abyss of the ocean, might result; and thus, by the various combinations, oppositions, and modifications of these expansive or contractile operations, new lines, or double, or parallel lines of elevation might be formed; or the original lines of uplift and consequent weakness may either have been extended, like the successive extensions of the cracks of a starred pane of glass, by every thermal variation, or have been altogether broken down.

By this rise of the range of the internal calorific influence up to, and its action upon, the inferior portions of the accumulated sediments, various kinds of granitoid and gneissic rock would have originated; the granite being the lowermost portion fused, so to express it, under intense pressure of the superincumbent heap, in the presence of water, of a temperature perhaps equal to red-heat. As this granitized mass was forced up by its own expansion, it fissured the semi-crystalline and unchanged strata above it, dragging up, like a giant on its shoulders, the circumambient pasty rock, and, laminating, streaking, and contorting it in the "squeeze and jam" of its intermural expression, produced the ribboned-structured mica-schist and gneiss.*

When we regard the extensive areas still exposed of the old gneiss and similar-aged rocks in various parts of the world, and which probably have remained uncovered by any sedimentary deposit whatever from the first hour that the golden sun tinged their brine-washed crowns to the present play of his cheering rays upon their grey and barren fronts, we may well ask if those oldest gneissic rocks have thus been formed?

We must, however, look upon these granitoid and gneissic foundations as the buttresses, denuded and weathered out in the lapse of incomprehensible ages from the originally circumambient beds, and exposed in this way to our view, rather than as dykes of molten matter, forced completely through open fissures into the upper air. We have alluded to the different ages of granite-formation and their outbursts by the influence of internal heat on successive sedimentary floors; may we thence look to find any difference of composition, marking the difference of the age in which each was generated and irrupted? Mr. Sterry Hunt has done something towards this knowledge. He has pointed out that the oldest granite contains most soda, and that the quantity of that alkali diminishes sensibly in the several granitic masses in proportion to the proximity of their epoch of formation to our times. Hence this proportional quantity of one chemical ingredient may some day be made subservient to an approximate registration of geological time upon the great chronological dial. As the first granites, or gneissic rocks, were worn down into submarine sediments, to be afterwards changed in the progress of natural phenomena into newer granites and metamorphic rocks, from those sedimentary materials the primeval oceans dissolved out and accumulated much of that soluble substance; and so, those regenerated and less alkaline granitoid rocks being again worn down, their sediments were also in the lapse of time formed into newer granites and schists with a still less quantity of alkaline matter.

But let us go back to the old gneiss and the law of upheaval by the rise of the range of internal heat beneath sedimentary masses. Were the old gneissic and granitoid rocks, that form the real nucleus of our present lands, generated, expanded, and uplifted on these principles and by those means? The evidence seems to incline towards this belief; and if so, there must have been a world of land and sea older than those remote ancestral island-domes and ridges that form the earliest recognized traces of our present lands. For there must have been *lands* to have furnished the materials of those sediments, the heaping-up and over-piling of which gave increased range to the subterranean heat; and there must have been waves and ocean-currents to have abraded and worn them down, and to have transported their finely divided particles into the abyss. And this still older world-crust—whether life-less or life-full—has been melted up by fervent heat, and fused into the adamantine foundations of the "everlasting hills."

---

* See Mr. Scrope's paper in THE GEOLOGIST, vol. i. page 361.

It is not, however, on the ancient physical geology of our globe that we wish to dwell at length in these chapters; our object is to treat more at large of the successive forms of the organized creatures which have inhabited it, and to portray in our descriptions and illustrations the whole of the common forms of those abundant tribes whose offices have been the most important in the past conditions of our planet, and whose remains are characteristic of our principal rock-masses.

Still, we could not avoid considering, first, the formation and uprise of those ancient lands of which these perished beings were the inhabitants. Our thoughts must naturally first turn to the soil, the shape and extent of the land, the form and elevation of the hills, the flow of the rivers, if any existed, to the rivulets and rills, to the beat of the waves on the shore, to the sunshine, the rain, and the dew; and then we seek to reclothe those ancient lands with plants, herbs, and trees, to bedeck them with flowers, and to repeople them with living creatures. Before we describe the first fossils we must think of the first land and the first water that trickled over its surface. We must think of the sky and the air, the sunshine and shadows, the storms and calms of that first age of terrestrial conditions.

Philosophers tell us of a central heat, still sufficient within the range of 800 miles below to fuse the most intractable rock. They tell us too of a gradual refrigeration of our planet, and refer many problems of former temperature to the ancient higher internal incandescence of our planet. Measure off on a roll the successive masses of rock-strata which we know by their superposition to be true indications of geological time, on a scale of 1½ inch to a thousand feet of vertical thickness, and your diagram will reach to a length of nearly nine feet.

Over the uppermost of these add a segment to represent recent deposits; it will scarcely be the eighth of an inch in thickness. Yet four thousand years at least have intervened since the parents of the human race trod the verdant floor of beauteous Eden. Take the next in order, the latest Tertiary age—the age of glacial drifts and icebergs, and a quarter of an inch will overlap the segment you have drawn. And yet for thirty thousand years at least the foaming cataract of Niagara has been cutting through the raised and consolidated strata of that vast age, for vast it must have been when whole species of maritime mollusca migrated many geographical degrees from their ancestral haunts to seek out warmer climes; when whole continental tracts were raised into the regions of perpetual snow; and again, the uplifted lands subsiding to their ancient levels, their shores were once more inhabited by the returned posterity of the out-driven shell-fish. Take the next segment of the rock-formations, and the caves disgorge the bones of hundreds of extinct pachyderms and ruminants. Compute the cubic space of the fleshly bulk of the collective carcasses of those exhumed by inquiring man alone, and their volume far surpasses the capacity of the cave to contain them; and yet for hundreds disinterred, thousands remain behind. Take the next age, and two thousand feet of sediment tell of still more extensive changes and still more extended time; and the next, and the next; and greater and greater becomes the thickness of the stony volumes of the earth's history, until in the coal-measures we have 15,000 feet and more of instructing leaves, and in the Silurian and the "bottom-rocks" 25,000 and 26,000 feet of evidential records.

These too are only the records of the periods of *active* deposit of sediment, and the minimum even of that. No indication is here of the periods (equally great, or greater) of cessation, nor of the far surpassing periods of re-generation and re-formation. The greatest amount of sediment which, according to our present information, can be permanently laid down in our deeper waters, over the range of our present seas, would probably not exceed in the aggregate, including even our littoral accumulations, a coating of more than three inches thick in ten thousand years; and yet we have at least a minimum thickness of upwards of 80,000 feet of consolidated sedimentary rock to explain as the result of natural agencies in past time.

The whole of nature teems with the sublime and beautiful, whether we turn to the starry firmament, with its planets and its suns, its comets and its meteors, and its showers of falling stars, the lightning and the tempests, to the contemplation of the incomprehensible distance of the heavenly bodies, or to the rapidity of their motion.

But what more sublime than the age of Time? "Ye paint me old! and why?" says the Dutch poet:—

"Ye paint me old! and why?
And doth my speed eld's frozen blood betray?
Methinks the storm-wind is not swifter flighted;
The rapid lightning scarce o'ertakes my way.
Ye think your hurrying thoughts perchance outrun me:
Go, race with sunbeams,—when they have outdone me,
Talk of my age,—I fly more swift than they."

* * * * *

"One glance—but one—
O'er the huge tombs of vanished Time, around ye,—
Mountains of ruins piled by me alone:
I did it:—I smote, yesterday,—to-morrow,
I wait to smite,—your cities,—you; go, borrow
Safety and strength, they shall avail you none.
Eternity was mine,—and still eternal
I hold my course,—God's being is my stay,—
I saw worlds fashioned by His words supernal:
I saw them fashioned,—saw them pass away.
I bear upon my cheeks unfading roses;"

* * * * *

"Take from my front the white locks Folly fancies.
My hair is golden, and my forehead curled;
My youth but sports with years. Fire are my glances."

* * * * *

"But give me too the hour-glass,—ever raining
Exhaustless streams untired;—for I am he
Who pours forth gems and gold, and fruits undraining,
And treasures ever new, or can it be
For desolation only? Do not new drops
Of dew replace in summer fervour's fallow dew-drops?
Fresh flowers replace each flower crush'd by me?

I, the destroyer, do it—without measure.
I fill creation's cup of joy,—man's lot,
That vibrates restlessly 'twixt pain and pleasure,
Determine;—in my youth his years forgot.
Worlds crumble;—Virtue mounts to Heaven;—no sleeping
In dust for me;—but, with bright angels keeping
God's throne, with God I dwell and perish not."

How imperfectly can human expressions shadow out the inexpressible age of the "Bottom-rocks!" What, then, was that old land like?

If for all these ages this globe has been cooling down, how much nearer to the surface *then* must have been the isothermal line of boiling-water temperature? Put it at fifty feet beneath the "rind of Earth;" then every spring and water-flow over the bare and barren sea-washed crests and ridges would be reeking with clouds of rolling steam. The sea would be ever giving off dense vapours, which the sun in vain would strive to dispel,—a thick mist would envelope the world! Nothing—no not even the lichen, would vegetate upon the glassy solid rock,—and every spot would be silent, barren, damp, and glistening grey.

Was this the state of the first land?

GEMS FROM PRIVATE COLLECTIONS.

III.-PHACOPS CAUDATUS; FROM THE DUDLEY LIMESTONE.

In the Private Collection of PROFESSOR J. TENNANT, F.G.S.

THE beautiful specimen of *Phacops caudatus*, which we figure in Plate V., has long been in the private collection of Professor Tennant. It is from the Upper Silurian limestone of Dudley, and would be a perfect example but for the exception only of its having the segments of the body somewhat bent inwards, and slightly distorted from their natural positions by pressure. The lateral edges and their segments are unfortunately obscured by being embedded in the matrix, so that they cannot be accurately delineated.

This characteristic species of Trilobite was first noticed by Brunnich, in 1781, under the name of *Trilobus caudatus*. It was subsequently termed *Asaphus caudatus* by Brongniart, Dalman, Dr. Buckland, and other writers. Burmeister, however, in his valuable work on the "Organization of Trilobites," called it *Phacops caudatus*, which generic determination modern palæontologists have followed.

One of the chief features in the species is the great prominence of the eyes and the distinctness of the numerous lens-facets into which those special organs are divided.

There are certain variations in the outlines and form of this, as well as of other species of Trilobites, which have been regarded by naturalists as sexual characteristics; judging upon these grounds, Mr. Tennant's specimen would be probably considered a female.

This species, *Phacops caudatus*, ranges in vertical stratigraphical distribution from the Lower Llandeilo flags to the Upper Ludlow rock, and it has also a considerable geographical range.

The species has been described at length by Burmeister, and also in the Decades of the Geological Survey.

FOREIGN CORRESPONDENCE.

BY DR. T. L. PHIPSON OF PARIS.

On the Crystalline form of Coal—Coal and Carburetted Hydrogen in Meteoric Stones—Coal that cuts Glass like the Diamond—Another word on the Artificial formation of Coal.

I HAVE just published in France some observations "On the Crystalline form of Coal."* In November, 1858, I picked up in London some fragments of coal that were perfect *rhombohedrons*, giving angles of 102° and 78°. This coal came from Sunderland. In December following I found many analogous specimens near the town of Glasgow, in Scotland, one of which measures nearly a foot in every direction. The coal-beds near Glasgow have been upheaved by trap-rock, and the immense pressure has given to the coal a crystalline structure that causes it to break under the hammer in rhombohedric fragments; and these, whatever be their size, give always the same angles, 102° and 78°. Graphite, which is known to be a variety of pure carbon, is found crystallized in short *hexagonal prisms* (laminæ), that is, in a form derivable from the rhombohedron. Coal and graphite belong therefore to the same crystalline system. This fact goes a long way to prove that coal must be regarded as a variety of pure carbon, and not as a combination of carbon, hydrogen, oxygen, and azote, as some have asserted. For the oxygen, hydrogen, and azote that coal gives on analysis are derived from the substances, such as bitumen, naphtha, vegetable remains, &c. with which it is mixed.

---

* *Bulletin de la Soc. d'Hist. Nat. de Strasbourg*, and *Journal de Pharmacologie de Bruxelles.*

It is a curious but well-known fact that substances which do not possess a crystalline structure may be made to take it under the influence of mechanical forces; thus, iron becomes crystalline by repeated percussion, and above we have an example of a crystalline structure being given by pressure. The foregoing facts will also tend to explain why coal sometimes takes the form of hexagonal prisms in contact with trap-rock. The rhombohedron and the hexagonal prisms are certainly the crystalline forms of carbon in the state of coal and graphite; whilst the diamond, as is well known, crystallizes in forms derived from the cube or the regular octahedron; whence carbon is *dimorphous.*

M. Wöhler, Professor of Chemistry in the University of Göttingen, has sent to the Academy of Sciences at Paris the following description of the composition of a meteoric stone:—

"I have just made the analysis of a meteoric stone which fell at Kuba in Hungary on the 15th of April, 1857. The aërolite in question is black, and its colour is owing to amorphous coal. It also contains—besides those elements generally found in meteorites—a certain quantity of organic matter, that is to say, a carburet of hydrogen similar to paraffine, to cozokerite, or to scheererite. The quantity of this bituminous matter is certainly very small; but I have assured myself of its presence by the most incontestable proofs. This organic matter is soluble in alcohol, and becomes carbonized by calcination. I have since found the same organic matter in the meteoric stone which fell in 1838 at the Cape of Good Hope. This stone is also of a black colour, and contains 1·5 per cent. of carbon. It is probable that this bituminous matter is a product of organic nature, and that the presence of coal in these meteoric stones is to be attributed to the action of heat upon the bituminous matter whilst the meteorite was in an incandescent state, *i.e.* during its passage through the terrestrial atmosphere."

This remarkable discovery, which we have given in the author's own words, would appear to be favourable to those philosophers who still look upon meteoric stones as products of our earth. We should not, however, without reluctance abandon another opinion:—When the periodicity of remarkable falls of aërolites became tolerably certain, Arago, in 1839, wrote: "We thus become more and more confirmed in the belief that there exists a zone composed of millions of small bodies, the orbits of which cut the plane of the ecliptic at about the point which our earth annually occupies between the 11th and 13th of November; it is a new planetary world beginning to be revealed to us." (*Annuaire*, 1839.)

It is now almost doubtless that there are other periods besides the November one.

Sir Isaac Newton once said that he took all the planets to be composed of the same matter as the earth, namely, earth, water, and stone, but variously concocted. "Recalling to mind the remarkable interview between Newton and Conduit at Kensington," says Alex.

Von Humboldt, "I would ask why the elementary substances that compose one group of cosmical bodies, or one planetary system, may not in a great measure be identical? Why should we not adopt this view, since we may conjecture that these planetary bodies, like all the larger or smaller agglomerated masses revolving round the sun, have been thrown off from the once far more expanded solar atmosphere, and been formed from vaporous rings describing their orbits round the central body?" (*Cosmos*, vol. i.)

At one of the recent meetings of the Academy of Sciences at Paris, our ever-active friend M. Jobard, of Brussels, director of the Belgian Musée d'Industrie, presented to the members a piece of anthracite found in a blast-furnace, and which possessed the following properties. In his amusing and instructive work of last year, entitled "*Les Nouvelles Inventions*," M. Jobard speaks of a species of coal, found in Belgium, that cuts glass as easily as does the diamond of a glazier. But it is only alluded to once in the whole four volumes, and his account of it is so short that we did not quite understand his meaning. Now it is evident enough: "I have the honour," says M. Jobard, "of presenting to the Academy a piece of coal which has become incombustible from having passed through a blast-furnace at Creuzot, in France. This coal, which was given to me by M. Mène, the chemist of the establishment, was originally of a poor quality, and appears to have taken some carbon from the rich coal with which it was mixed in the furnace together with coke, and it has undergone this transformation without any change in its form."[*]

It may be well to remark here that, when M. Jobard begins to theorize on chemical subjects, he appears to be one of those who belong to a region which the Germans are fond of calling "cloud-land." But our friend is a good observer of facts. "This product," he continues, "cuts glass with the noise of a glazier's diamond, which proves that it is as hard as the latter (!),[†] and that, after being reduced to powder, it may possibly serve to replace diamond-powder in the workshops of lapidaries, or certain other polishing powders. . . . This transformed coal is not, however, isomorphous with the black diamond; it is lighter and more friable."[‡]

M. Elie de Beaumont remarks that M. Jobard's coal has the form, colour, aspect, and density of anthracite.

---

[*] The absorption of carbon by, or the crystallization of the volatilized carbon upon, other substances is prettily displayed in the case of straw, matting, or other foreign substances lying on the surface of the materials in the coke- and cinder-ovens. These become impregnated and coated with metallic-like films and masses of crystals; which action of deposit appears to take place after the doors of the furnace are closed, when there is no escape for the carbon volatilized by the heated mass beneath.—Ed. Geol.

[†] At this rate quartz, flint, ruby, &c. should possess the hardness of the diamond.—T. L. P.

[‡] I have been told by the men employed in the South Eastern Railway Company's coke-ovens at Folkestone that the extreme points of the coke-lumps, which are there made for the locomotives on that line, will cut glass like the diamond. I have not, however, verified the statement by actual experiment.—Ed. Geol.

In speaking, in a former article,* of the artificial formation of coal, we gave the names of some philosophers who had realised to a certain extent the problem in question before M. Barhouiller laid the results of his experiments before the public. I regret to say that I find the name of M. Beudant was forgotten, not only in my article, but also in M. Barhouiller's paper. I believe that, if Beudant were now living, he would be able to affirm that the results obtained by M. Barhouiller had been already realised, or nearly so, by himself; for he says, in his *Minéralogie* (p. 210 of the Edit. of 1844), "It results from various experiments which we have commenced, but which certain unavoidable circumstances have not permitted us to terminate, that, when vegetables are submitted to temperatures ranging between 180° and 200° (centigrade), and under a proper degree of pressure, they are converted into black substances in every respect similar to lignite, coal, and bitumen."

P.S. I ought to have mentioned in my last article, in respect to the statements of the submarine volcano, near Leghorn, that M. Senevier, the French Consul at Leghorn, was misinformed, and had sent an erroneous statement to the Academy of Sciences at Paris.

NOTE ON THE STAGONOLEPIS OF ELGIN, by Sir R. I. Murchison.

We have received a communication from Sir Roderick Murchison relative to our Note (p. 124) on Stagonolepis, in which Sir Roderick reiterates his conviction of the correctness of his statement that the rock in which those remains were found is of "Old Red Sandstone" age. He says, "Sedgwick, Malcolmson, Robertson, Anderson, Duff, Hugh Miller, and Gordon, as well as himself, have called it 'Old Red.' Certain geological theorists who have not visited the district, and who judge or opine certainly from the character of the beast, still throw doubt upon the decision of stratigraphical observers. The note ought to have stated, that, despite the testimony of those who have explored the district, and class the sandstone of Elgin as 'Old Red,' some geologists, who are guided by palæontology only, are so much startled at the discovery of a Reptilian of this high order in such ancient rocks, that they have thrown doubts upon the true age of the deposit, and suppose it may prove to be of Oolitic date.

"This would be fair, and ought to be stated in the next number. It is barely possible, but still possible, that I may be wrong, but the note as it stands is not correct. This is intended for the Editor, with whose work in other respects I am very much gratified."—R. I. MURCHISON.

---

* THE GEOLOGIST, vol. i. p. 202.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

GEOLOGICAL SOCIETY OF LONDON.—ANNUAL GENERAL MEETING.—*February 18th*, 1859.—Prof. J. Phillips, President, in the Chair.

The Reports of the Council, of the Museum and Library Committee, and of the Auditors, having been read by the Secretary, were adopted, and ordered to be printed.

The President stated the Council had unanimously awarded the Wollaston Medal to Mr. Charles Darwin, F.R.S., F.G.S., in testimony of their appreciation of the great value of his long-continued and successful geological researches both abroad and at home, and both in the practical and the philosophical branches of the science.

The President then announced the award of the balance of the proceeds of the Wollaston Fund to Mr. Charles Peach, of Wick, N.B.

The President then proceeded to read his Anniversary address, briefly alluding to the loss the Society had of late sustained in the decease of several Fellows and Foreign Members, among whom were H. Warburton, Esq., the Dean of Ely, the Duke of Devonshire, Lieut.-Col. Sir W. Reid, Sir W. G. Cumming, Rev. E. Tagart, Herbert Mackworth, Esq., Richard Taylor, Esq., Prof. Weiss, &c.

The ballot for the Council and Officers was then taken; Prof. John Phillips, M.A., LL.D., F.R.S. was re-elected President.

ORDINARY GENERAL MEETING.—*February 23d*, 1859.—The following communications were read:—

1. "On the occurrence of Liassic Deposits near Carlisle." By E. W. Binney, Esq., F.G.S.

The author's attention had been drawn by Mr. Richard B. Brockbank, of Carlisle, to the district lying between Carthwaite, on the Carlisle and Maryport Railway, and the Solway, especially about Aikton and Oughterby, as containing a limestone, supposed to belong to the coal-measures, but found by Mr. Brockbank to contain an Ammonite and other fossils, which he thought to be Liassic. Mr. Binney subsequently went over the district with Mr. R. B. Brockbank, and found that, although the country is thickly coated with boulder-clay or till, yet lias-limestone and shales were observable in several spots, in wells, streams, &c., especially at Quarry Gill, Fisher's Gill Farm, and in Thornbybrook, south-east of Aikton. *Gryphæa incurva* and other *Gryphææ*, with Oysters and Ammonites, characterise these beds. The area occupied by the Lias is known to extend under the rising ground lying between Crofton and Orton, on the south, and the Solway, on the north, comprising Aikton, Thornby, Wiggonby, Oughterby, and probably other places on the rising ground between the Carlisle and Maryport and Carlisle and Port Carlisle Railways.

This paper was illustrated by specimens of the Lias, forwarded by Mr. E. W. Binney.

2. "On the Fossils of the Lingula-flags or Zone Primordiale.—I. Paradoxides and Conocephalus from North America." By J. W. Salter, Esq., F.G.S., of the Geological Survey of Great Britain.

After briefly noticing the relations of the "Zone Primordiale" instituted by M. Barrande, the author described the remains of a large *Paradoxides* sent from the vicinity of St. John's, Newfoundland, by Mr. Bennett. The fossil belongs to a new species of *Paradoxides*, the largest yet known (9½ inches broad), and termed *P. novo-repertus* by Mr. Salter. A new species of *Conocephalus*, from Georgia, was also described from a specimen brought to England by Dr. Feuchtwanger, and placed in the Great Exhibition of 1851; it is named *C. antiquatus* by the author. As these two genera have as yet been known only in the "Zone Primordiale," Mr. Salter regards the above-mentioned specimens as indicative of the existence of that geological formation in the countries here mentioned.

The author also referred to an obscure spécimen of *Asaphus*, from the "Calciferous sand-rock" of Canada, which he once, but on insufficient grounds, published as a *Paradoxides*.

The specimens alluded to in the paper were on the table.

3. "On a new species of Dicynodon (*D. Murrayi*) from near Colesberg, South Africa." By Prof. T. H. Huxley, F.R.S., Sec. G.S.

For the original specimen from which Prof. Huxley first obtained (in the spring of last year) evidence of the existence of this species he was indebted to the Rev. H. M. White, of Andover, who subsequently put the author in communication with the discoverer of the fossil, Mr. J. A. Murray, and the latter gentleman having written to his father, resident in South Africa, obtained for Prof. Huxley a large quantity of similar fossil remains. One specimen in particular having been carefully chiselled out by Mr. Dew, afforded a complete skull of this peculiar and previously undescribed species of *Dicynodon*.

The author described the distinctive features of this skull in detail. *Dicynodon Murrayi* is distinguished from all the already known species by the following characters:—

(1.) The plane of the upper anterior face of the nasal and premaxillary bones would, if produced, cut that of the upper face of the parietal at an angle of about 90°.

(2.) The supratemporal fossæ are much longer from within outwards than from before backwards, owing partly to the shortness of the parietal region.

(3.) The alveoli of the tusks, the transverse section of which is circular, commence immediately under the nasal aperture, and extend forwards and downwards parallel with the plane of the nasal and upper part of the premaxillary bones, and do not leave their sockets until they have passed beyond the level of the posterior end of the symphysis of the lower jaw.

(4.) The nasal apertures are altogether in front of the orbits.

(5.) The length of the upper jaw in front of the nasal apertures is certainly equal to one-third, and probably to one-half, the whole length of the skull, which is between six and seven inches.

(6.) The os quadratum is about half as long as the skull.

These peculiarities are regarded as sufficient to distinguish *Dicynodon Murrayi* from all others; and the author stated that he should reserve the description of many other anatomical features, which are probably more or less common to other Dicynodons, such as the bony sclerotic, the bony interorbital septum and vomer, the characters of the humerus, of the pelvis, and of the ribs, for another paper, in which other Dicynodont remains will be considered.

The specimen illustrating the paper was exhibited by Prof. Huxley.

4. "On the Coal found by Dr. Livingstone at Tete, on the Zambesi, South Africa." By Richard Thornton, Esq.

Forwarded from the Foreign Office by order of Lord Malmesbury.

Mr. Thornton states that this coal is free-burning; showing no tendency to cake; containing very little of either sulphur or iron, a large proportion of ash, but only a little gaseous matter. The result of the trial (made in the steam-launch) of this coal and its appearances favour, in the author's opinion, the idea that the coal, when taken from a deeper digging (that which Dr. Livingstone had sent was collected at the surface of the ground), will probably contain less ash and a little more gaseous matter.

March 9th, 1859.—The following communications were read:—

1. "On some Minerals from Persia." By the Hon. C. A. Murray, C.B., &c.

Forwarded from the Foreign Office by order of Lord Malmesbury.

The mineral specimens referred to were obtained from the district between Tabriz and the Caspian, especially from the Karadagh Range, and consist of native copper, chrysocolla, red oxide and black oxide of copper, malachite, azure-copper, bornite, copper-glance, copper-pyrites, varieties of galena, zinc-blende, magnetite, specular iron-ore, manganese-ore, orpiment, sulphur, and brown-coal. The series of copper-ores appears to indicate the existence of considerable masses of metallic mineral, probably in lodes or regular veins. The lead-ores have the appearance of having been taken either from veins of small size, or from near the surface of the ground.

The specimens alluded to were exhibited.

2. "On the Veins of Tin-ore at Evigtok, near Arksut, Greenland." By J. W. Tayler, Esq., F.G.S.

These tin-veins, of which there are about twenty, extend over an area of about 1,500 feet in length by 80 feet in breadth; and they run in various directions, some E. and W., others N.E. and S.W., and others N. and S. They vary from 10 inches to ¼ of an inch in width; in the largest veins the tin-ore occupies about 1 inch of one side of the vein. The veins nearly all occur in a great vein of felspar and quartz; which contains also ores of lead, copper, zinc, iron, and molybdena, associated with cryolite, fluor-spar, zircon, &c.

Specimens from Evigtok were exhibited, from the Collections of Prof. Tennant, F.G.S., and the Society.

3. "On the Permian Chitonidæ." By J. W. Kirkby, Esq. Communicated by T. Davidson, Esq., F.R.S., F.G.S.

After having fully noticed the progress of our knowledge respecting the palæozoic Chitons, and those of the Magnesian Limestone in particular, the author described in detail the characters of *Chiton Loftusianus*, King, and *Chiton Howseanus*, Kirkby, and a new species, referred with some doubt to *Chiton C.* (?) *cordatus*; also *Chiton antiquus*, Howse, which Mr. Kirkby refers to the subgenus *Chitonellus*, as well as two new species, *C. Hancockianus* and *C. distortus*. The specimens on which all these species have been determined have been found in the Magnesian Limestone of the neighbourhood of Sunderland, Durham, and chiefly in that of Tunstall Hill.

The author particularly alluded to the great similarity that some of the plates of these fossil Chitons have at first sight to *Patellæ* and *Calyptrææ*, and recommended that especial care should therefore always be taken in the determination of patelliform fossils.

The paper was illustrated by fine pencil-drawings by the author.

4. "On the Vegetable Structures in Coal." By J. W. Dawson, LL.D., F.G.S., Principal of M'Gill College, Montreal.

After referring to the labours of others in the elucidation of the history of coal, the author remarks that in ordinary bituminous coal we recognise by the unaided eye laminæ of a compact and more or less lustrous appearance, separated by uneven films and layers of fibrous anthracite or mineral charcoal. As these two kinds of material differ to some extent in origin and state of preservation, and in the methods of study applicable to them, he proceeds to treat of his subject under two heads:—1st. The structures preserved in the state of mineral charcoal. This substance consists of fragments of prosenchymatous and vasiform tissues in a carbonized state, somewhat flattened by pressure, and more or less impregnated with bituminous and mineral matters derived from the surrounding mass. It has resulted from the *subaërial* decay of vegetable matter; whilst the compact coal is the product of *subaqueous* putrefaction, modified by heat and exposure to air. The author proceeded (after describing the methods used by him in examining mineral charcoal and coal) to describe the tissues of Cryptogamous plants in the state of mineral charcoal. Among these he mentions *Lepidodendron* and *Ulodendron*, also disintegrated vascular bundles from the petioles of Ferns, the veins of Stigmarian leaves, and from some roots or stipes. He then describes tissues of Gymnospermous plants in the state of mineral charcoal; especially wood with discigerous fibres and also with scalariform tissue, such as that of *Stigmaria* and *Calamodendron*; and the author remarks that probably the so-called cycadeous tissue hitherto met with in the coal has belonged to *Sigillariæ*.

The next chief heading of the paper has reference to structures preserved in the layers of compact coal, which constitute a far larger proportion of the mass than the mineral charcoal does. The laminæ of pitch- or cherry-coal, says Dr. Dawson, when carefully traced over the surfaces of accumulation, are found to present the outline of flattened trunks. This is also true to a certain extent of the finer varieties of slate-coal; but the coarse coal appears to consist of extensive laminæ of disintegrated vegetable matter mixed with mud. When the coal (especially the more shaly varieties) is held obliquely under a strong light, in the manner recommended by Goeppert, the surfaces of the laminæ of coal present the forms of many well-known coal-plants, as *Sigillaria*, *Stigmaria*, *Poacites* (or *Næggerathia*), *Lepidodendron*, *Ulodendron*, and rough bark, perhaps of Conifers. When the coal is traced upward into the roof-shales, we often find the laminæ of compact coal represented by flattened coaly trunks and leaves, now rendered distinct by being separated by clay.

The relation of erect trees to the mass of the coal, and the state of preservation in which the wood and bark of these trees occur,—the microscopic appearances of coal,—the abundance of cortical tissue in the coal, associated with remains of herbaceous plants, leaves, &c., are next treated of.

The author offers the following general conclusions:—

(1.) With respect to the plants which have contributed the vegetable matter of the coal, these are principally the *Sigillariæ* and *Calamiteæ*, but especially the former.

(2.) The woody matter of the axes of *Sigillariæ* and *Calamiteæ* and of coniferous trunks, as well as the scalariform tissues of the axes of the *Lepidodendreæ* and *Ulodendreæ*, and the woody and vascular bundles of ferns, appear principally in the state of mineral charcoal. The outer cortical envelope of these plants, together with such portions of their wood and of herbaceous plants and foliage as were submerged without subaërial decay, occur as compact coal of various degrees of purity, the cortical matter, owing to its greater resistance to aqueous infiltration, affording the purest coal. The relative amounts of all these substances found in the states of mineral charcoal and compact coal depend principally upon the greater or less prevalence of subaërial decay occasioned by greater or less dryness of the swampy flats on which the coal accumulated.

(3.) The structure of the coal accords with the view that its materials were accumulated by growth without any driftage of materials. The *Sigillariæ* and *Calamiteæ*, tall and branchless, and clothed only with rigid linear leaves, formed dense groves and jungles, in which the stumps and fallen trunks of dead trees became resolved by decay into shells of bark and loose fragments of rotten wood which currents must have swept away, but which the most gentle inundations, or even heavy rains, could scatter in layers over the surface, where they gradually became imbedded in a mass of roots, fallen leaves, and herbaceous plants.

(4.) The rate of accumulation of coal was very slow. The climate of the period, in the northern temperate zone, was of such a character that the true conifers show rings of growth not larger, or much less distinct than those of many of their northern congeners.* The *Sigillariæ* and *Calamites* were not, as often supposed, succulent plants. The former had, it is true, a very thick cellular inner bark; but their dense woody axes, their thick and nearly imperishable outer bark, their scanty and rigid foliage, would indicate no very rapid growth. In the case of *Sigillariæ*, the variations in the leaf-scars in different parts of the trunk, the intercalation of new ridges at the surface representing that of new woody wedges in the axis, the transverse marks left by the successive stages of upward growth, all indicate that at least several years must have been required for the growth of stems of moderate size. The enormous roots of these trees, and the conditions of the coal-swamps, must have exempted them from the danger of being overthrown by violence. They probably fell, in successive generations, from natural decay; and making every allowance for other materials, we may safely assert that every foot of thickness of pure bituminous coal implies the quiet growth and fall of at least fifty generations of *Sigillariæ*, and therefore an undisturbed condition of forest-growth enduring through many centuries. Further, there is evidence that an immense amount of loose parenchymatous tissue, and even of wood, perished by decay; and we do not know to what extent even the most durable tissues may have disappeared in this way, so that in many coal-seams we may have only a very small part of the vegetable matter produced.

---

* Paper on Fossils from Nova Scotia, Proc. Geol. Soc. 1847.

Lastly. The results stated in this paper refer to coal-beds of the middle coal-measures. A few facts which I have observed lead me to believe that in the thin seams of the lower coal-measures remains of *Næggerathia* and *Lepidodendron* are more abundant than in those of the middle coal-measures.* In the upper coal-measures similar modifications may be expected. These differences have been to a certain extent ascertained by Goeppert for some of the coal-beds of Silesia, and by Lesquereux for those of Ohio; but the subject is deserving of further investigation, more especially by the means proposed in this paper, and which I hope, should time and opportunity permit, to apply to the seventy-six successive coal-beds of the South Joggins.

There were exhibited at this meeting Coal, Minerals, Fossil Leaves, &c. from Sarawak; presented by R. Coulson, Esq.

GEOLOGISTS' ASSOCIATION.—On Thursday, the 8th February, the second ordinary meeting of this Association was held at St. Martin's Hall. The Rev. Thos. Wiltshire, M.A., V.P., in the chair.

Mr. Hyde Clarke read a paper, in which he sketched out a plan for the organization of local committees in conjunction with the Association, by which the work of the Government surveyors and others labouring in the geological field might be usefully followed up, and supplemented by the bringing together of new facts, as local circumstances might favour their collection. He adverted to the valuable services which had been rendered to the science by ladies, and mentioned several whose names were well known as accomplished geologists.

He believed that much remained to be done, in more minute classification of the strata, &c., by local researches, and that much good was to be effected by announcements of new minerals, particularly such as would be useful as manures, for building-materials, or in connexion with the manufactures; as well as by notice of such operations as new mines, quarries, wells, pits, railways, roads, tunnels, &c., of land-slips; observations on springs, on thermal, superficial, and subterranean waters; electro-magnetic observations on mineral bodies; earthquakes in particular districts; the rates of erosion of shores, and of new depositions; the like of river-operations; of recent and ancient abrasions; and many other particulars, which would be not only interesting as bearing on points of theoretical geology, but as likely to throw light on questions of great practical and economic importance.

From these records Mr. Clarke thought valuable reports might be drawn up, from time to time, which would exhibit the progress of geological knowledge; and that thus a really useful work would be effected by the Association.

March 8.—Professor J. Tennant gave a lecture on Mineralogy. The lecturer stated that as many as 520 species of minerals were described in one English treatise on the science; and, when anyone looked at a map of the world and compared the small area of the British Isles and their mineral wealth with the extent of such territories as that of Canada and Hudson's Bay, and the treasures to be there probably discovered, he must perceive the importance of some acquaintance with the science of mineralogy. Australia, a few years since, was only known as containing a few sheep-walks, and as a penal settlement. In 1851, a piece of stone was received in London and placed in the Great Exhibition, where it created much sensation. It was a gold nugget. Such nuggets had been frequently picked up in Australia; stones containing the yellow metal had been built into walls and houses; but no one had, previously to this time, regarded them. Some thought the metalliferous substance to be iron-pyrites, others that it was copper-pyrites; but if these persons had been acquainted with a very simple test—a common file—they could have easily ascertained the difference between pyrites and gold.

---

* I may refer to my late paper on Devonian Plants from Canada for an example of a still older coal made up principally of remains of Lycopodiaceous plants of the genus *Psilophyton*.

The rapid progress of the colony since this discovery was familiar to everyone, and the history of the gold-nugget trade would display prominently the value of observant habits. The lecturer then described the various large nuggets which had been brought into this country, the largest being four feet two inches long by ten inches wide. This was melted and produced fine gold of the value of 6,905*l.* 12*s.* 9*d.*, only twenty-one ounces of stony matter remaining.

Diamonds in the rough state had been thrown aside by the gold-seekers, and many other valuable substances were frequently wasted in ignorance of their nature and properties.

The most interesting part of mineralogy was crystallography, and the lecturer gave illustrations of the methods of distinguishing crystals by their forms, fracture, transparency, degrees of hardness, &c.

Some specimens of cryolite, from Greenland, were exhibited, to show the importance of the study of mineralogy, in developing the means of cheapening useful commodities. Aluminium, at the time of the Paris Exhibition, could not be obtained for less than 4*l.* per ounce. It was soon afterwards offered for 2*l.* per ounce; but, since cryoline had been used, it was reduced to less than 15*s.* per ounce. This was an important metal, and although hitherto only known as a curiosity in the laboratory, would probably, before long, become of the highest commercial importance.

The lecturer concluded with some statistical accounts of the values and annual produce of the chief British minerals.

Malvern Natural History Field-Club.—The annual meeting of this Club was held on the 21st ult., at the Museum of the Club, in Malvern, when the President, the Rev. W. S. Symonds, of Pendock, delivered the annual address.

Mr. Symonds recorded with deep sorrow the loss the Society had sustained during the last year by the death of two of their most active and distinguished members—the Rev. T. T. Lewis and the Rev. F. Dyson. Sir Roderick Murchison, in his new edition of "Siluria," renders a full acknowledgment of the valuable assistance he received from Mr. Lewis in the foundation and establishment of "the Silurian system." The life-long conduct of such men as Mr. Lewis and Mr Dyson will ever prove an important refutation to the belief, sometimes entertained, of the incompatibility of the pursuit of science with religious energy and duty; inasmuch as the departed were well known as faithful ministers of the Gospel, who, while they loved the study of nature, as the exponent of the vast and varied plans of the Divine Mind, did not make science, as some do, their idol, nor exalt philosophy above those nobler principles, the moral relations of man to God.

Mr. Symonds entered at some length into the mineralogy of the Malverns, and their microscopic crystallography.

Speaking of the Cambrian rocks, he said,—You will, I am sure, allow me to take this opportunity of congratulating an illustrious honorary member of our Society, Sir R. I. Murchison, upon the publication of his new and long-expected edition of "Siluria;" and perhaps you will allow that I have not chosen an unillustrative point in my address, at which to offer our congratulations, when I tell you that Sir Roderick has rendered a very important addition to the records of geology, by the discovery of a series of sedimentary deposits of more ancient date than those rocks of the Longmynd, in Shropshire, of North Wales, and of Ireland, which we have been accustomed to term Cambrian. These oldest known sedimentary rocks occur on the north-west coast of Scotland, and are unconformably surmounted by mountain masses of conglomerates and sandstones, now known to be of Cambrian age, and the equivalents in time of the Longmynd and North Welsh deposits. This lowest Cambrian deposit is a gneiss.

On reading Sir R. Murchison's account of this most ancient gneiss, some time ago, I determined to examine closely certain stratified deposits which are in contact with the Malvern syenite, to which Sir R. Murchison alludes (in "Siluria," p. 103), as consisting of "chloritic schists, quartzite, and highly micaceous schists, almost passing into gneiss." For this purpose, I have twice explored the whole length of the tunnel near Malvern Wells, and have given particular attention to certain schistose rocks on the Swinyard, Midsummer, and Ragged-stone Hills, at he southern extremity of the Malvern range. These investigations lead me to nfer that many crystalline masses, formerly believed to be of plutonic origin, must ow be considered as altered sedimentary deposits, and that much of what local eologists are in the habit of classing under the convenient head of "Malvern yenite" is an ancient sedimentary rock, much displaced and altered, but which nay turn out, on further investigation, to be the equivalent of the old Scotch neiss. I hope to be able to say more on this subject at our next meeting.

Respecting the Lingula-flags of Malvern (black shales) Sir Roderick Murchison dheres to his former correlation of these rocks, and places the Lingula-flagstone f Wales, the Stiper-stones, the "Holly-bush sandstone" of Malvern, and the Tremadoc and Arenig slates, as the base of his Lower Silurian rocks, which conformably overlie the Cambrian deposits just alluded to. Sir Roderick has given an excellent section ("Siluria," p. 105) of the strata which intervene between the south end of the Malverns and Ledbury, and which I recommend you to consult, while, at the same time, I still hold to the opinion that our "Holy-Bush sandstone" should be correlated as a Cambrian deposit of the same age as the Longmynds.

You are aware that great interest attaches to our Malvern black schists, through the discovery, by Professor John Phillips, of Oxford, of sundry little crustaceans, belonging to the family of Trilobites, of the genus *Olenus;* as, also, through Mr. Hugh Strickland's discovery, on the occasion of one of our general meetings, of the *Agnostus pisiformis*, another crustacean found in the same low horizon of life in Bohemia, Scandinavia, and North Wales. You will, therefore, be interested in my discovery during last autumn, when accompanied by my friend, Mr. Pitson, of another organic link in the evidence which connects our Malvern black schists with the "primordial zone" of distant lands This fossil is termed "*Dictyonema sociale*," and is a Bryozoon, "which," says Sir R. Murchison, "is exceedingly interesting, as showing a probable connexion between the Fenestellidæ and the Graptolites;" it also furnishes an "additional reason for regarding the 'Olenus-shales' of Malvern as belonging to the primordial zone" ("Siluria," p. 47, and p. 562). This fossil, like the little trilobites above mentioned, is by no means abundant, and requires careful searching for. I have, however, conducted several geologists to the locality, and we have generally succeeded in carrying off a prize. Specimens have been sent to the Malvern, Worcester, and Jermyn Street Museums.

From the Lingula beds to the Upper Llandovery rocks there is, at Malvern, a great hiatus, the Llandeilo, Caradoc, and Lower Llandovery rocks being absent; and the place of those deposits is occupied by an outburst of igneous rock, known as the "trap-bosses" of Prof. Phillips. I must refer you to "Siluria" for Sir Roderick's explanation of the identification of the rocks and fossils of the "Bala-limestone" with those of Caer-Caradoc; suffice it again to repeat that the term "Caradoc" must be blotted out from the list of our Malvern rocks and fossils, for the "Bala-beds" are certainly wanting, as I, years ago, maintained. The determination of a transitional or passage-zone of rocks near Llandovery is an important point, proving that there is no breach between the Lower and Upper Silurian strata. There is no doubt that our so-called Caradoc-beds of Malvern are no more than Upper Llandovery or May Hill deposits. Prof. Sedgwick first detected the mistake in the May Hill district. My brother naturalists will be interested to learn that a beautiful fucoid was found in a fragment of the Llandovery sandstone by our friend Mr. Edwin Lees, and that this specimen is figured in Sir Roderick's new edition of "Siluria" (p. 106).

I have several times visited the tunnel near Ledbury; and, a few days ago, accompanied by Mr. Francis Brooks, I carefully examined the strata from the entrance to the farthest extremity at which the workmen have arrived. In most respects the section is similar to that of the railway-cutting north of Ludlow; but the strata are more inclined. The "fossil-band" of grey micaceous sandstone, with fragments of plants and crustacea, and associated with red marls, is exposed as at Ludlow. The rock now worked is the Downton sandstone.

The discovery of the Lower Old Red fish-remains last season, at Cradley, near Malvern, was then alluded to, and also the important detection, by Sir Roderick Murchison, of the reptilian character of the *Stagonolepis Robertsoni*, from the

Upper Old Red sandstone of Scotland. Portions of *Holoptychius* and *Pterichthys* had been found by Dr. Melville, Mr. Lightbody, and Mr. Roberts, in the yellow sandstone of Farlow, near Ledbury Mortimer, and "Old Red" plants have been found by Mr. Symonds in the same passage-beds, on the Daren, near Crickhowell. Good specimens of Permian plants have been found near Kidderminster, by Mr. G. Roberts, some of which are in the Worcester Museum.

An important discovery has also been made by the widow of the late lamented Hugh E. Strickland.

The mammalian remains found by Mr. Strickland in the Cropthorne and Avon drift and gravels were imbedded in a silt containing fresh-water shells, such as Limnæa, Bythinia, and of species now living in the adjacent river. The remains consist of the teeth and bones of rhinoceros, elephant, deer, bos, horse, &c.

Among these is a fine head of *Bos primigenius*, from the interior of which Mrs. Strickland obtained a perfect *marine* shell (Turritella). The discovery of this shell is of great consequence to the naturalist, inasmuch as he cannot avoid the conclusion that this relic of the ancient ox was originally buried in a *marine* deposit, out of which it was washed to be re-interred in the fresh-water-drifts of the ancient Avon.

The Club proceeded, after the address, to elect the officers for the ensuing year. Mr. Symonds, at the request of the Society, and on the motion of Sir Charles Hastings, again accepted the office of President; Mr. Godwin Lees, the Worcestershire botanist, was elected Vice-President, in the place of the Rev. F. Dyson, deceased; and Mr. Walter Burrow was re-elected Hon. Secretary.

The field-meetings were arranged as follows:—

May 19, Apperley Court, to meet the Cotteswold Club, on the invitation of H. Strickland, Esq. June, Ledbury. September, Pershore.

Nearly twenty members and corresponding-members were proposed for election.

THE COTTESWOLD NATURALISTS' FIELD-CLUB.—This Club held its meeting on the 16th instant, at the Ram Inn, Gloucester. T. B. Ll. Baker, Esq., of Hardwicke Court, having read the address reviewing the proceedings of last year, to the regret of the Club, vacated the presidential chair, which he has so ably and worthily filled from its establishment in 1846, with a distinct intimation that he could no longer continue to occupy it, in consequence of the amount of time and labour he is obliged to devote to the reformatory movement with which his name has become so honourably associated. Professor Buckman retired from the office of Honorary Secretary. W. V. Guise, Esq., of Elmore, was unanimously elected President, and Mr. John Jones, of Gloucester, Honorary Secretary.

A discussion followed upon the desirability of throwing open the Club to any duly qualified person who might be desirous of joining it, instead of limiting its numbers to the fifty gentlemen already composing it, and the proposed alteration was finally determined upon. Some members of the Club made an excursion to the Lias-Marlstone Quarries at Churchdown and Brockworth, others to Lassington and Highnam; while a few of the geologists devoted the interval between the proceedings referred to and dinner-time to the examination of Mr. Jones' cabinets of fossils.

After dinner, the new President read a paper upon the "Oolites in the neighbourhood of Bath," which gave rise to a long and animated discussion between Dr. Wright, Professor Buckman, the Rev. W. S. Symonds, and others.

An invitation from Mr. Strickland, of Apperley Court, to meet the Malvern Natural History Field-Club, at his house, in May, was communicated by the Rev. W. S. Symonds, of Pendock, and accepted.

The following places were named and approved of as places of meeting during the ensuing season:—Cheltenham, May 11th; Dursley, June 15th; Newnham, July 13th; Swindon and Abury, August 17th; Cirencester, Sept. 14th.

In the commissariat department, the Club was never better served than by Mr. Nunn upon the present occasion, whose catering was not only duly appreciated by, but received its due meed of praise from, all assembled.

[We should have been glad to have been furnished by our correspondent with ome fuller account of the geological, as well as of the administrative and convivial roceedings of this meeting. Possibly the former might have been preferable ood for those of our readers who had not the gratification of partaking of Mr. Nunn's excellent provisions.—ED. GEOL.]

NOTES AND QUERIES.

THE SUPPOSED TRIASSIC MAMMALIAN REMAINS.—"DEAR SIR,—In the foreign correspondence by Dr. Phipson in your last number, I observe that Mr. Pentland, in writing to Mr. Elie de Beaumont, refers to my recent discovery of ancient Mammalia, and supposes they are derived from the 'Triassic Bone-bed of Dundry, near Bristol,' but the beds in this locality belong to the Inferior Oolite. In a note you suggest their being from the Dolomitic conglomerate. As it is desirable there should be no mistake as to their locality or geological position, I write to say they were found in a fissure of carboniferous limestone at Holwell, near Frome, and that as these were associated with the teeth of the *Microlestes*, the vertebræ and teeth of *Thecodontosaurus*, and fish-remains of the genera *Acrodus*, *Hybodus*, *Sauricthys*, *Lepidotus*, *Gyrolepis*, &c., I have little doubt the conglomerate is chiefly derived from beds of Triassic age, and that these mammalian remains are therefore not so old as the Dolomitic conglomerates.

"It may interest your readers to know that with the *Microlestes* I have also found teeth of the Muschelkalk *Placodus*, the first indications I believe of this formation or its fauna being represented in this country.

"I hope soon to communicate fuller information with reference to Triassic-beds in the West of England.—Yours truly, CHARLES MOORE, F.G.S., Cambridge-place, Bath."

AGE OF DRIFT DEPOSITS.—"SIR,—Observing that the last number of THE GEOLOGIST contains rather scanty notices under the head of 'Queries' from correspondents, and deeming them of some importance to the uninitiated, permit me to ask from what quarter I can obtain the best information respecting the 'drifts' which are now and then met with in different parts of this country. For instance, may I conclude that the drift in the vicinity of Thirsk in Yorkshire is of the same age as the drift-beds at Barrow in Leicestershire, resting on the Lias? You will, perhaps, be amused at the question, as the contents are dissimilar. I presume that drifts may be of very different epochs; but some more general notice in your valuable periodical may interest others besides myself.—G. W. WAKEFIELD."—In the new diagram map of the British Isles published this day, and which has been executed under my direction, the range and course of the Great Northern or Glacial Drift is laid down, as far as our present knowledge goes. There are local and other "drifts," gravels, and loams of newer age, the geology of which has not yet been properly worked out, although we believe Mr. Prestwich has accumulated a considerable amount of material towards the elucidation of their histories. We shall be glad of every information and particulars of the "drift," gravel, and brick-earth deposits.—ED. GEOLOGIST.

LOCALITIES FOR FOSSILS AROUND LONDON.—DEAR SIR,—"There are a great many students in Geology, who, like myself, can find little time for running far into the country in search of practical knowledge during the academical portions of the year, but who could nevertheless occupy an afternoon occasionally, and to great advantage, in studying such formations of fossils as are to be met with round London. But it is difficult for a beginner to find out these places, and I think that one page of The Geologist devoted to a list of such places within half-an-hour's or an hour's run of London, with directions as to the exact spots, and the beds to be found there, would be a great boon to those who, like myself, are advocates for practice as well as theory. If you should consider this favourably, I am sure others as well as myself will feel greatly obliged for your kind assistance.—Yours very truly, A Beginner."—We have for some time past contemplated giving occasional papers on the characters and features of the chief geological localities, not only around London, but also by the sea-side, and in the vicinity of larger and important towns. Our correspondent will find in vol. i. p. 208, a list of the fossiliferous localities near London.—Ed. Geologist.

Notice of the Occurrence of Mammalian Remains in the Valley of the Soar, Leicestershire.—"In compliance with the admirable suggestion of Mr. Prestwich, the following notice of teeth and other elephantine remains found in the valley of the river Soar may be of service. This valley, from its commencement in the neighbourhood of Lutterworth, to its termination at Red Hill, where it joins the great Trent Valley, has been formed by the denudation of the Lower Lias, the Upper New Red Marls, and the Keuper Sandstone. The denuded materials, ground and mixed together, are piled up on the sides of the valley to a depth, in many places, of 120 feet and upwards. Bones and teeth of ox, deer, horse, &c., are very frequently met with, whenever the alluvial soil of the valley is excavated, especially near the present river-bed; but the teeth of elephants have all been found in the drift-clays and gravels that flank each side. In the neighbourhood of Barrow the Lower Lias has been denuded to the extent of from 160 to 200 feet, as shown by some remaining outliers of that formation. The denuded materials, consisting of pieces of shales, blocks of limestone, bones of saurians and shells, are scattered far and wide over the adjacent country, but more particularly on the north-eastern side of the valley, the set of the current having been, no doubt, determined in that direction by the old rocks of Charnwood Forest. The altitude of the valley at Barrow above the sea-level is about 180 to 200 feet; and its width, from the escarpment of the Middle Lias (Marlstone) on the north-east to the slopes of Charnwood on the south-west, is about 7 or 8 miles. Barrow lies near the centre; and in the neighbourhood of that place the drift-clays and gravels immediately covering the Lower Lias vary from 6 feet to 20 or 30 feet. It was here the remains of mammalia were found, according to the account of the quarryman. When first uncovered, the entire skeleton of an elephant about 11 feet long was seen lying upon its side, a few inches only above the denuded beds of the Lower Lias, and about 6 feet from the surface. So perfect was it at that time, that the integuments were plainly discernible, but exposure to the atmosphere caused it to crumble into dust and small fragments; and from the whole skeleton it was only possible to preserve portions of the tusks, three teeth (one very perfect, large, and but little worn on the grinding surface, the others in fragments), part of a femur (thigh-bone), and a large fragment of the scapula (shoulder-blade). The large tooth is from the lower jaw, left side; and, from the character of the grinding surface, would appear to belong to Dr. Falconer's genus *Elephas*, sub-genus *Euelephas*, species *antiquus;* it measures seven inches deep on the side at the middle part, and must have been eight or nine when perfect, the end of the fangs being now broken; it is thirteen inches long on the side; the grinding surface is seven and a half inches by three inches in the central part, tapering off at each end to about one and a half inches; there are twelve layers of dentine divided by layers of cement of nearly equal width; the cement splits readily, and would admit of the tooth being divided into segments. Some yards from the spot where these remains were found two other teeth were turned out of the drift-clay, but no bones accompanied them; they had evidently been rolled considerably, the grinding-surface of both being very much worn; and, judging from the character of the ridges and the thickness of the cement, they would appear to belong to Dr. Falconer's genus *Elephas*, sub-genus *Loxodon;* they are both lower-jaw-teeth; one from the right, the other from the left side, providing these points can be fairly deduced from the wearing of the grinding-surface. The largest of them measures on the grinding-surface ten inches long by four inches wide in the centre, tapering off at each end to one inch and a quarter; the greatest depth inside at the middle part is six inches: it has ten layers of dentine. The other tooth is smaller; its length on the grinding-surface eight and a half inches; by three inches wide in the centre, tapering off to one inch at each end; it has nine layers of dentine.—It may be useful to notice here that all the economic clays, viz., those for making bricks and tiles, found on the Red Marls, and also the beds of fine sand and gravel, are all of comparatively recent formation; the true Red Marl—a mixture of clay and sand,—whether above the Kenper Sandstone or below it, cannot be made into bricks or tiles, and the fine clays used have been formed by the washing out of the Red Marl, the sand having been deposited in one place, and the clay more finely comminuted, and hence of less specific gravity, laid down in another. They are thus found in most Triassic districts as basins of clay of unequal depth and extent, and as beds of sand; it is in these beds and basins, and in the gravel-pits, that the young geologist may expect to find mammalian remains. The geological maps of the Ordnance Survey, although generally very accurate in the boundaries of formations, at least wherever I have examined them, are still defective in one particular and calculated to mislead. Miles of surface are laid down as Red Marl, Lias, &c., where there are really drift-clays, sands, and gravels, of recent age, and this in places where the drift is upwards of 100 feet deep. What is wanted is a *Map of the Drift.* There is no doubt that, under this comprehensive term, a number of deposits of different ages are all confusedly grouped together; but such a map would at least greatly facilitate the search for Mammalian remains.—J. Plant, Leicester."—On the large diagram-map just executed under my direction, the course and extent of the Great-Northern Drift is laid down as far as our present knowledge extends. Additional information is still, however, very desirable.—Ed. Geologist.

Sand-pipes near Swainstone, Isle of Wight.—"Dear Sir,—In accordance with the wish of Mr. Prestwich, I beg to make known to your readers an interesting section of half a mile in length in this island, lately exposed by a cutting for a road near Swainstone, the seat of Sir John Simson, Bart. Its interest chiefly arises from its bearing on the date of the formation of swallow-holes,* in conjunction with the period of the upheaval of the vertical chalk-strata which are well known to form a belt through the Isle of Wight. At the spot in question the chalk-strata are not quite vertical; their slight dip being to the north. The cutting divides the Plastic Clay (Woolwich beds) obliquely at its eastern commencement, and extends along the northern escarpment of the central belt of chalk-hills. The uppermost beds of the chalk are divided at first obliquely to their line of stratification; but at the western end of the cutting these beds are cut through almost exactly parallel to their line of inclination. This cutting is of the width of an ordinary road, and presents very numerous sections of swallow-holes, nearly all of which have a southerly dip, *i.e.* across the line of stratification of the chalk. The inclination of the swallow-holes to the south is rather less than the dip of the chalk to the north; hence the inference I draw is, that the swallow-holes were formed at a period subsequent to the first upheaval of our chalk-belt; but at a period prior to that when the present verticality of the chalk was attained—a point to which I submit some interest may be fairly attached. The swallow-holes otherwise present features little differing from those ordinarily met with. In no instance can I find flints which can be considered as water-worn; for the most part they are fractured, and some are of very large size. In most of the swallow-holes flints may be seen lining, as it were, the circumference; while the centre is composed of clayey gravel. In those nearest the eastern extremity of the section clay predominates, having a great similarity to the Plastic Clay, if I may judge from its tenacity, &c.—Yours, &c., Ernest P. Wilkins, F.G.S., Newport."

Films of Selenite.—(See vol. i. p. 444.)—"Thin plates of the desired thickness may be easily procured by a little tact and careful manipulation. Thus, under water, and with a fine and thin lancet, carefully free a lamina of the crystal along its line of cleavage; then, introducing a thread of unspun raw silk, work it forward until the plate be disunited. Float upon your glass slide, and mount it in the desired manner.—F. S., Churchdown."

---

* Our correspondent here uses the word swallow-holes with a meaning somewhat different from that in which it is usually applied. Swallow-holes are the conical cavities on the surface of some parts of the country into which water runs either permanently or during heavy rains (see Prestwich "On some Swallow holes near Canterbury," Quart. Jour. Geol. Soc., vol. x. p. 222), and though these swallow-holes are regarded as actual representatives of the original condition of many of the conical hollows, the sections of which are often seen in the exposed chalk-strata, yet the latter are called sand-pipes, sand-galls, &c.

The Archæology of Palæontology.—"In a work entitled 'Recherches et Observations Naturelles de Monsieur Boccone, Gentilhomme Sicilien,' published at Amsterdam, 1674, and the substance of which was communicated to the Royal Society of London, may be found many illustrations of the scientific opinions then current. The twenty-eighth letter is on the 'Cornu Ammonis.' He concedes to the popular feeling the opinion that the generality of stones which represent shells are mere casts of hardened clay which have been compressed between actual shells; but he maintains the true character of Ammonites as being veritable shells, though he advances the theory with diffidence. In the next letter he discusses the nature of the fish-teeth found so plentifully in Malta; and after giving a full account of the singular opinions then prevalent as to the non-natural production of these, he concludes that they are veritable marine remains, and are proofs either that the sea has flowed where they are now found, or that they have been vomited by adjacent burning mountains. The whole work will repay the student of the early history of natural science.—S.R.P."

Blocks of Lower Oolite in the Drift-clay at Leicester.—"In excavating for the sewerage works at Leicester, on the eastern side of the river, blocks of Lower Oolite rock were discovered, at a depth of from twelve to fifteen feet below the surface, in a stiff clay. A great number of them are of large size, and over a quarter of a ton in weight; all are much rounded and worn, some of them being polished in a high degree, and showing sections of shells and crinoids in all directions. No marks of scoring or grooving have been found on those examined, although such have been carefully searched for. Some of the blocks are complete masses of shells, principally Ostrea, with portions of encrinites and corals, all of Lower Oolitic species. The area over which these blocks were found was very considerable; its boundary on two sides was tolerably accurately defined by other sewerage excavations in which no blocks were found. The small size of the openings made for the sewers, and the hundreds of blocks taken out, may give some idea of the number remaining covered. In no previous excavations in the drift-clay (and there have been a great many) have blocks of this character and size been met with, although rolled Oolitic fossils are common in the gravel-beds. The present nearest outcrop of Lower Oolite is distant from this spot twelve miles south-east; it must therefore have been a strong current that rolled such blocks over the intervening Liassic hills.—J. Plant, Leicester."

The Late W. Kennett Loftus, Esq., F.G.S.—We regret to announce the untimely death of W. K. Loftus, Esq. It occurred at sea, in the ship *Tyburnia*, a week after he quitted Calcutta on his return to England. He was educated at Caius College, Cambridge, and his early devotion to geological study attracted the notice of Prof. Sedgwick and Sir H. de la Beche, who recommended him for an appointment on the commission for fixing the boundary of Turkey and Persia. He remained four years in Asia under the command of Major-General Sir W. F. Williams of Kars. The result of his geological investigations was embodied in an elaborate report, with a map of the frontier from Mount Ararat to Mohammereh. It was communicated to the Geological Society by the Earl of Clarendon, read and subsequently published in their journal. Whilst in the East he devoted his leisure to antiquarian pursuits in Lower Chaldea and Susiana, on which countries and their antiquities he published a large volume on his return to England. He subsequently proceeded to Nineveh to complete the investigations commenced by Mr. Layard, and fifty cases of his Assyrian discoveries enrich our British Museum. In the latter part of 1856 he set out for India to fill a post in the Geological Society of India, and proceeded to the Rajmahal Hills. But the climate soon affected his constitution. He was ordered to Rangoon for the benefit of his health. The change was of no avail, and he embarked for England. He died of abscess on the liver at the early age of thirty-seven, and leaves a wife and five young children. He was passionately devoted to geology, and had a mind peculiarly adapted for close and patient investigation. Whatever he did he did well. His various pamphlets are evidence of his zeal and industry in the cause of science;

but it is only those who enjoyed his friendship that can fully appreciate his worth. His honest kindness, his gentle nature, and warm generous heart, will remain long in the memory of the large circle of friends and acquaintances who mourn his loss and cherish his memory.

LOCAL MUSEUMS.—"DEAR SIR,—The worthy people who, with so much public spirit, form these collections usually begin at the antipodes, and work backwards, so that their immediate neighbourhood is the last locality to be illustrated. This is particularly unfortunate, since the chief value of local collections consists in their being representative of their district with its peculiar features; and it is exceedingly disappointing to go in search of relics which perhaps have derived their very names from the place where you seek them, and to find musty garments from Polynesia instead of the objects of your inquiry. It will conduce to the convenience of many of your increasing staff of readers, if you will kindly invite brief notices of local museums; and, after a sufficiently long interval, publish a list of them to serve as a guide to the traveller. I inclose a brief commencement.—Yours truly, S. R. PATTISON, Torrington-square."

"PUBLIC GEOLOGICAL MUSEUMS.

PENZANCE.—Museum of the Royal Cornwall Geological Society. Rich in mineral specimens. Rich in Petherwyn fossils, unarranged, and in other Devonian fossils of Cornwall.

TRURO.—Royal Institution.—Some good specimens from the Devonians.

EXETER.—Athenæum.

TAUNTON.—Archæological Society. David Williams's collection, and other Devonian fossils from the western counties: many unnamed; some named by Mr. Salter; much work still to be done.

DORCHESTER.—Some good mammalian remains; and well stocked with insect-remains and plants from the Eocene tertiaries.

RYDE.—New collection. Good in Greensand fossils and Wealden bones."

—Approving entirely of Mr. Pattison's suggestion, we invite at once further communications from those gentlemen who have knowledge of the state of any of the provincial Natural History institutions.—ED. GEOL.

THE FIRST FOSSIL MEGACEROS.—"Ballaug his peculiarly interesting to the geologist, as the locality where the first tolerably perfect specimen of the great Irish elk was discovered. At a farm known by the name of Balla Terson, to the eastward of the new church, and about a mile from the foot of the mountains, are two oval depressions in the drift-gravel platform; they are on either side of a by-road which leads down from the great northern high-road to the sea-shore. It was in the most westerly of the two that the celebrated fossil, figured in the "Ossemens Fossiles," tom. iv. pl. 8, from a sketch transmitted by Prof. Jamieson to Baron Cuvier, was discovered. Mr. Oswald Douglas (*Edinburgh Journal of Science*, 1826, vol. iii. p. 28) has well pointed out the character of the basin, and the circumstances under which the elk was found.—'It is a small turf-bog, about a hundred yards long by fifty wide, and occupied in the central part by a pool, varying in size according to the moisture of the season, in which aquatic plants luxuriate. The superficial stratum is a light and fibrous peat, of good quality, enveloping some fragments of bog-timber. The thickness of the peat in the centre of this basin is six feet; but it thins out considerably towards the margin. Under the peat is a bed of fine bluish-white earthy sand, from two to three feet in thickness. This rests upon a deposit of white marl, containing delineations of shells. The marl is of a fibrous laminar structure, and when dry as white as chalk. The shells are delineated white upon a somewhat darker ground, and are discovered by separating the layers, but are seldom, if ever, found in their original state. In this marl a great quantity of bones of the elk were found at the first opening of the pit, occurring at various depths in the marl; but the deeper they were found, the more fresh and perfect did they appear, and near the bottom complete heads were met with. The skeleton which was presented by the Duke of Athol to the Museum of the University of Edinburgh was found quite at the bottom of the marl, where the bed was about twelve feet thick. The different bones, though partly connected, were in much disorder. An ingenious blacksmith of the village possessed himself of the skeleton, and, in putting it together according to his own ideas of what the animal was, found himself short of a few bones, which he supplied from the relics of other animals, and it was some tim before the fraud was discovered. This shell-marl would appear to rest on the boulder-formation, according to the description given by the workmen. When they pierced it, water immediately sprung up and inundated the pit. It is worth while to notice that the peat and timber are confined to the surface of the basin, and that in them no remains of the elk were found; and this has been universally the case in the Isle of Man. Under the portion of the Ballaugh Curragh which stretches down towards the Ballamona and pours forth its accumulated waters by the Carlaane drain into the sea, similar basins to these have been discovered, containing the remains of the elk, but they are all below the great turf-bogs, in which we meet with trunks of trees, both upright and prostrate.* There is no doubt that great changes have taken place throughout this northern area, even within the period which has been called historical. The old map of the Isle of Man, performed by Thomas Durham, as given by Speed, Camden, Chaloner, and in Blean's Atlas, exhibits ancient lakes, both in the south and north of the island. There was the Malar lough, in Lagazayre, a lough in Andreas parish, and Bala lough, the corruption of which has given the present name of the village in its vicinity—Ballaugh. The great lake of Myreshaw, or Mirascogh, seems to have occupied, at one time, a large portion of the Curragh, near the base of the mountains; and, so late as 1505, we read of a grant of one-half of the fishery of it to Huan Hesketh, Bishop of Man, by Thomas, Earl of Derby. The names of several estates in this neighbourhood, such, for instance, as Ellan Vane, White Island, &c. point to their original condition, as well as the nature of some of the holdings, which show that even since the Act of Settlement, there has been a large territory once occupied by water reclaimed to the purposes of husbandry.' Further interesting particulars are noted in the work from which the account has been extracted,—'The Isle of Man,' by the Rev. J. G. Cumming, M.A., F.G.S. —Yours, &c. F. S. A."

REVIEWS.

Das Mineralreich in Bildern. Naturhistorisch-technische Beschreibung und Abbildung der wichtigsten Mineralien. Von Dr. J. G. von Kurr. Stuttgart: Schreiber & Schill. 1858.

The Mineral Kingdom. By Dr. J. G. Kurr, Professor of Natural History to the Polytechnic Institution of Stuttgart. Edinburgh: Edmonston & Douglas, 88, Princes Street. 1859.

Dr. Kurr is Professor of Natural History to the Polytechnic Institution of Stuttgart, and he has in this work offerred a most valuable elementary volume to the public.

The original work is in German, nicely printed on stout paper, bound in a prettily-designed ornamental cover, and illustrated by twenty-two plates.

The size Dr. Kurr has chosen for his work is a fine folio, and the handsome plates by which examples of the most important minerals, rocks, and petrifactions are displayed, deserve high praise for the judgment manifested in the selection, and for the beautiful manner in which they are drawn and coloured.

The name of the editor of the English translation does not appear, but his work seems to have been carefully and conscientiously performed. The price of the English edition is, however, much more than that of the German; the plates being the same, and probably imported in their finished state into this country.

---

* See the statement of Bishop Wilson, "History of the Isle of Man," p. 314:—"Large trees of oak and fir have been found, some two feet and a half in diameter; they do not lie promiscuously, but where there is plenty of one sort there are generally few or none of the other."

We have never seen any elementary book on mineralogy—ever especially a difficult subject to simplify—in which so much really scientific grounding was so naturally and intelligibly put. The reader is first introduced to the forms of minerals, then of crystals; then to the characters of hardness, specific gravity, electrical and chemical qualities, &c.; thence he is led to special mineralogy, taking first in order the precious stones; then follow in due succession, the augitic minerals, the felspathic, micaceous, zeolitic, and the calcareous. Compounds of baryta, of strontia; salts of potash, of soda, of magnesia, of ammonia; combustible matters; the metals and their ores.

The following passages describing the use of the blow-pipe in mineral analysis, will afford an example to our readers of the unassuming, easy, and simple, and yet thoroughly scientific style in which the book is composed:—

"As the purposes to which minerals may be applied, as well as the knowledge of individual species, stand in very close relation to their chemical composition, it is important to acquire dexterity in the analysis of minerals; and for this purpose either the moist or dry method may be employed. The latter consists principally in the use of the blow-pipe, the former in the solution of bodies in water, acids, &c., and the application of certain re-agents by which precipitates of particular colours and conditions are thrown down. In both cases the object is either to obtain decomposition, or new combinations, which may once more be analysed.

"In using the *blow-pipe*, small fragments of the mineral may be held either on charcoal or in platinum forceps; so that, first, the fusibility, and then the escaping vapour or deposit left on the charcoal, as well as the residue, is examined, either by reducing it in the inner flame, or by forming from it, along with borax, soda, or salt of phosphorus, a pearl-like drop, which is also to be considered with reference to its colour and appearance. It is to be kept in mind, in using the blow-pipe, that the point of the flame has an *oxidizing* power, and the inner blue cone has a *reducing* influence, that is, it has the power of deoxidizing; also that metals easily fused or reduced should not be held in the platinum forceps. Many bodies, such as chalk, become exceedingly brilliant when heated, others colour the flame at once, or after being held in it for some time. Thus, for example, all calcareous minerals colour it vermilion-red, strontium gives a brilliant purple-red, lithium a pale purplish-red, potassium a violet, sodium a pure intense yellow, baryta a green, boracic acid a pale green, acetate of copper a green, chloride of copper a blue, and the presence of chlorine may be easily distinguished in this way by the addition of some oxide of copper: while, on the other hand, the presence of copper, be it of ever so small amount, may be easily recognized by the bright blue flame on moistening the test with a drop of hydrochloric acid. The colour which certain metallic oxides impart to a bead or pearl of borax, which has been obtained by burning on charcoal, when heated on a platinum wire, is likewise important Thus, the oxide of cobalt colours it blue, the oxide of copper imparts a green colour, and, if a granule of tin is added, it becomes red; peroxide of iron makes it yellow when hot, and olive-green when cold; protoxide of iron gives a grass-green, oxide of chromium an emerald-green, oxide of manganese an amethyst-red, oxides of manganese and iron together give a blood-red or garnet-colour, and so on; while the oxides of zinc, lead, and bismuth do not change the colour of the bead. Further details will be found in the description of the individual minerals. The analysis by water is best performed in a closed glass-tube, or in a small retort over a spirit-lamp, by which means small drops are deposited on the colder part of the tube. This experiment serves at the same time to distinguish the water from the carbonic acid, both of them producing small beads in the borax pearl.

"The presence of carbonic acid is best recognized int he moist way, by solution in hydrochloric and nitric acids until effervescence takes place. Sulphur and sulphuric acid may be detected by using finely-powdered specimens along with soda in the inner flame, by the aid of which a sulphuret of soda is produced, and this, when moistened by a drop of water, and brought into contact with a silver coin, leaves a brown stain, and gives off an odour of rotten eggs (sulphuretted hydrogen).

"The presence of siliceous earths is best ascertained by melting the powdered mineral along with borax or soda, while to the clear pearl which is formed there is to be added salt of phosphorus; and thus, after continued heating, the siliceous earths may be recognized in the shape of beads or points. The analysis by the moist way may be performed either with acids or water. Water can only dissolve a few natural salts, as, for example, rock-salt, alum, carbonate of soda, sulphate of soda, potass, salts of magnesia, protoxide of iron, oxides of copper and tin and lime; the solution of each of these has a peculiar taste, and when evaporated in a watch-glass, leaves behind the dissolved salt, which may now be readily analysed by the ordinary chemical process.

"The acids act on several compounds of silica, especially such as contain water (the hydrous silicates), as, for instance, the zeolites; they have also a solvent action on calcareous felspar, so that the silica separates like a jelly or slime; other silicates must first be melted, or mixed with alkalies, if they are to be further examined. On the other hand, the acids dissolve most metallic oxides, with a determined colouring, which is indicated to some extent in the accounts of the individual minerals."

The relations of the chemical constituents to crystalline forms is admirably set forth in the same easy and definite manner; and the chapter on this subject contains a valuable table, displaying the Latin and English names, the symbol, electrical relations, the atomic weight, specific gravity, colour and appearance, modes of occurrence, &c., of minerals. The minerals noticed are also described in the same terse and explicit way, and for the student this must be regarded as one of the best, if not the very best, elementary treatise. All it teaches is necessary to be known, and to be relied upon, while he has neither to wade through a mass of irrelevant matter, nor to learn under the dread of having to reject, on future reading, anything he has, from this book, acquired.

On Copper-Smelting. By HYDE CLARKE, C.E. London: Mining Journal Office, Fleet Street. 8vo. 1858.

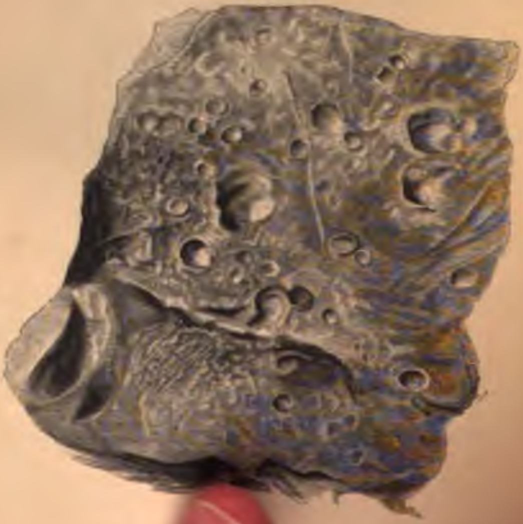
This pamphlet, a reprint of a report of a paper read before the Society of Arts. contains much valuable information on copper-smelting, and a considerable amount of statistical details of the copper-trade.

A New Geological Chart, showing at one view the Order of Succession of the Stratified Rocks, with their Mineral Characters, Principal Points, Average Thickness, Localities, Uses in the Arts, &c. Arranged by JOHN MORRIS, F.G.S., Professor of Geology in University College. London: James Reynolds, 174, Strand.

In our last number we noticed one of the many admirable tables and sections for the publication of which Mr. Reynolds, of the Strand, is so well known, and it is with much pleasure we notice this tabular chart, which we have received as a new publication since our last issue.

What the title professes the work fulfils. We have, in the centre, coloured spaces, in which the succession of the beds and their thicknesses are duly registered and supported, on the one hand, by concise descriptions of their uses in the arts, and their mineral characters; on the other, by some half-dozen names of the characteristic points of each division, and the like number of localities in which each division is typically displayed.

Little is necessary to be said of such works, and we feel ourselves only called upon to recommend them, or point out their defects, for the benefit of our numerous readers. Of this chart, we would say that it is worthy of a place alike in the library of the student or the proficient in geological science, and that we are pleased to find that Professor Morris has modified the nomenclature of the different divisions of the Crag, in a manner to rectify the objectionable terms hitherto in use, to which we alluded in our notice of his former production.



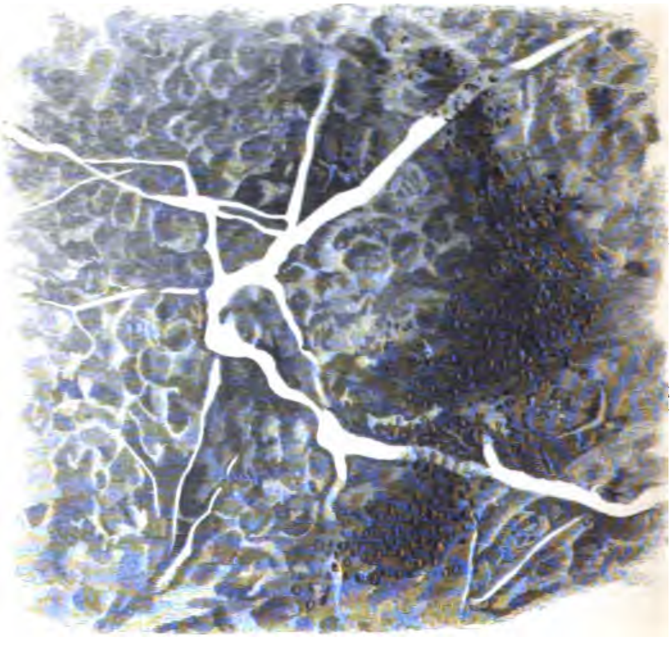
RAIN-DROPS [illegible]-Rocks" of the Longmynd,

In the Mu[illegible] Geology, Jermyn Street.

S. J. Mackie del.

of
us
n
at
g
s,
s,

ss,
not
this



RIPPLE-MARKS, SUN CRACKS, RAIN-DROPS abraded by the Surf, and WORM-HOLES in the Sheltered Hollows.—From the "Bottom-Rocks" of the Longmynd.

In the Museum of PRACTICAL GEOLOGY, Jermyn-Street.

S. J. MACKIE del.

THE GEOLOGIST.

MAY, 1859.

THE COMMON FOSSILS OF THE BRITISH ROCKS.

By S. J. Mackie, F.G.S., F.S.A., etc.

(*Continued from page* 160.)

Chap. 3 (*continued*). *The Remnants of the First Life-World, and the Bottom-rocks.*

What then was that old land like?

First, from the structural and physical characters of the primeval rocks we may best gather some knowledge.

In Europe, however, but few are the recognised remnants of those primitive lands; and those few, bare and bleak, return as yet no definite answers to our inquiries.

In the northern parts of Sweden and Norway are large tracts of the oldest gneiss, and in Bohemia M. Barrande has described enormous masses of stratified rock, devoid of fossils, and apparently of Cambrian age, as forming the natural base of his Silurian basin; but in that region, as also in Scandinavia, the earliest traces of animal life belong to the Primordial Zone, or that of our Stiper-stones and Lingula-flags, and we have no exact knowledge of the lowermost crystalline masses, which are probably gneissic.

In Central France there is also a large tract of the oldest gneiss, covered only by a few patches of lacustrine coal, and which not impossibly may never have been submerged, but may remain to this hour nearly as it rose above the sea, save in the effects of denudation and atmospheric weathering of long past ages, and in its thin crust of grey lichens, and its mantle of scanty herbage, which thus may grow where Coal and Tertiary plants during former eras found scanty sustenance.

In our own isles, all that remains of the first land are the old gneissic regions in the Orkneys, and in the north of Scotland, near Cape Wrath; and these we have questioned hitherto in vain for any traces of living things. All their secrets are still firmly locked up in their compact, crystalline, adamantine breasts.

Whether any traces of the old gneissic rock—the equivalent of the Laurentian Group—are yet to be found beneath the mountain-masses of the primitive sediments formed upon its shores (our Cambrian rocks, the equivalents of the American Huronian group), further researches, or rather, perhaps, future excavations or borings, can alone determine. Probably, however, the original lands, on the shores of which the Welsh and Irish Cambrian deposits were formed, have sunk beneath the ocean with that old great western continent, the *débris* of which remains in the Upper Palæozoic and Triassic deposits.

We must, then, for the present, leave the nature and conditions of the first land in that obscurity in which ages of time have enveloped it, and turn to the earliest stratified deposits on its shore,—our Cambrian or "bottom-rocks,"—for our first intelligible data of the earth's early history.

Some portions of these primary sediments remain in Caernarvon. The grits, 8,000 feet thick, of Harlech, in North Wales, belong to this age; and equivalent rocks rise from beneath the Lower Silurian near St. David's Head, in South Wales. Vast masses are also found at Bray Head, in Ireland, and a patch also probably occurs at Charnwood Forest, in Leicestershire, although the last is possibly only an altered Silurian deposit.

For a long time it was believed, from their crystalline character, that the schists, quartzose, and felspathic rocks of the Isle of Anglesea were more ancient than any of the strata of the adjacent mainland. But this is not the case, for it is now well ascertained that they are but altered Silurian beds, and that the rocks from which they, as well as the slates of Llanberris and Bangor were derived, have long since subsided beneath the waves.

Passing the Menai Straits, towards the west flanks of the mountainous range of Snowdon, we find "huge buttresses of very ancient grit, schist, slate, and sandstone," of Cambrian date.

But, after all, the best British example of lowest sedimentary or "bottom-rocks" occurs at the Longmynd mountains, in the typical region of "Siluria," Shropshire. And there and at Bray Head only (with one or two isolated exceptions, referred to subsequently) have any traces of fossils as yet been found.

I remember, many years since, seeing the Longmynds, when I knew very little about Geology, and nothing at all of the history of those hills, and thinking, as I passed them, what *old* hills they looked. The late Professor Edward Forbes and others have expressed the same feeling; and certainly there is something very remarkable in their appearance. The valley to the west of them is bounded by some low hills of micaceous schist, ranging along the base of a craggy ridge of trap mountains, of which the Wrekin forms the northern extremity, and continued on the south side of the Severn by those of Acton-Burnell, Frodesley, the Lawley, Caer Caradoc, and Hope-Bowdler. These, like the Wrekin, have the longest diameter from north-east to south-west, and rise very abruptly, at an angle of 60°, from the plain below. The vale in which Church Stretton is situated separates the trap mountains from the remarkable mass of hills called the Longmynds, which gradually rise to the height of 800 feet, and then with a level and nearly unvarying summit stretch for several miles towards Bishop's Castle. A peculiar squareness seems to characterize these mountains, and from Stretton Vale, whence three or four series of hills are seen rising one above another, this feature is particularly apparent. The individual mountains are generally separated from each other by a narrow deep glen, traversed in its length by a small stream, sometimes foaming in cascades over rugged ridges, and sometimes more gently flowing beneath overhanging woods. The Longmynds for the most part are covered with heath and a short grass that furnishes extensive pasturage for numerous flocks of sheep; and from their flanks brooks and streamlets break out and flow northward into the pla of Shrewsbury, or, trending southward, water the country between Bishop's Castle and Ludlow.

The lowest strata of the Longmynds range along the western side of the Stretton valley, and consist of thin, fragile, glossy schists, or clay-slate, with two or three minute layers of siliceous limestone, of scarcely more than an inch in thickness. These beds, partially interfered with by bosses of eruptive trap-rock, dip to the west-north-west, and are overlaid by a vast and regular series of hard purple or plum-coloured, greenish, and grey schistose flagstones and siliceous grits. Quartz-veins occur here and there, but on the whole the mass consists of schistose and gritty sandstone, often finely laminated, and scarcely at all affected by slaty cleavage. These highly inclined beds are overlaid in the direction of their dip by other masses of purple sandstone, conglomerates, and schists, of very considerable dimensions, the highest of which pass conformably under the Stiper-stones and other Lower Silurian strata. The thickness of these Longmynd rocks, as taken at the out-crop of their highly-inclined edges, is stated by the Government surveyors at 26,000 feet.

Fossils were first discovered in these beds* in 1856, by Mr. Salter, Palæontologist of the Geological Survey, in nearly vertical beds of hard flaggy sandstone, occurring along the strike of the Longmynds about a mile and a half east from the principal ridge, and which form part of a series of bluish-grey sandstones, alternating with purplish slaty beds, lying below the conglomerates and red-sandstones of the Portway, and above the thick series of dark-olive schists exposed at Church Stretton.

From the upper olive shales (Lign. 1, Stratum 2) to the hard grey grits of the Portway (Stratum 8), through a series of beds of more than a mile in thickness, the ripple- and worm-marks are conspicuous.

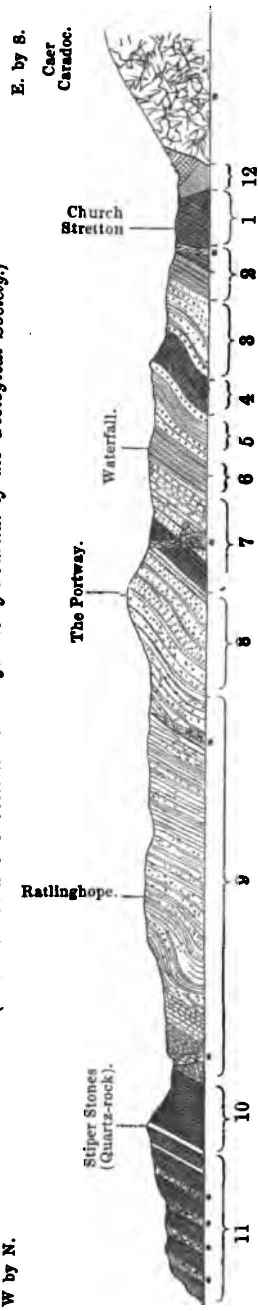
The time was when men wondered at the strange forms which nature produced in the quarries and in the rocks, and assigned superstitious tales and qualities to such natural phenomena. The past eneration disputed about he plastic virtues of the arth, and fancied that in ossils they saw the sports f nature or the germs f future beings. But nodern geologists, acting n the principle of observing the actual phenomena going on around us, —of studying and noting the things which *are*, and of referring the phenomena of the past to *this* standard,—have acquired a power and lucidity of reasoning unrivalled among the speculative sciences. The shales, schists, sandstones, and conglomerates are the ooze, sand, and beaches of the primeval seas, and, denoting a shallow line of coast, in themselves present the first indication of the proximity of dry land. By this reasoning we learn more;—that these primeval strands were flat and level shores, from which the tide receded, for the sun's warm rays bearing down upon them baked and fissured the slimy ooze; and innumerable impressions of these "sun-cracks" still traverse the surfaces of

---

* The Oldhamiæ, found in 1847 by Dr. Kinahan in the Cambrian rocks of Bray Head, were the first relics found in the Cambrian rocks. Of these we shall speak presently. Burrows of Annelides have also been obtained at Bray Head by Dr. Kinahan; one trumpet-shaped form of which from thence has been named by that gentleman *Histioderma Hibernica*.

SECTION OF THE LONGMYND.

(*From Mr. Salter's Section in the Quarterly Journal of the Geological Society.*)



Silurian.
- 12. Wenlock Shale, &c., let down 2,000 feet by a great fault.
- 11. Lower Llandeilo rocks (dark grey slates, with bands of igneous rocks.)
- 10. Lingula-flags (dark shales).

9. Coarse red sandstone and shales.
8. Hard grey grits. (Worm-burrows in the shaly partings.)
7. Coarse sandstone and shales. (Wave-marks and worm-burrows.)
6. Grey rippled flags, at Light Spout waterfall. (Worm-burrows.)
5. Purple shales and saudstones, alternating.
4. Red Shales. (Wave-marks.)
3. Fine-grained greenish sandstone. (Worm-burrows and Palæopyge.)
2. Hard olive-coloured shales; some beds ashy. (Worm-burrows?)
1. Dark olive shales.

* Greenstone and other eruptive rocks.

[*Lign.* 1.]

the beds, while myriads of little circular hollows remain,—the imprints of primeval showers. Strange that such fleeting incidents should be the most ancient records of the world, and stranger still that tracks of the soft worms and sea-weeds of the primeval shores should be the first organic fossils. Two holes in the sands upon our shores mark to the fisherman's eye the habitation of the lob-worm. On the wave-marked surfaces of these primitive shales, hundreds of such worm-burrows are crowded together in the greatest profusion. Some are small, others large, and in pairs, indicating the entrances and the outlets, as in those now living on our coasts. Sometimes the burrow-holes, obliterated by the rasping action of the waves on the flat shores, have been preserved in the hollows of the ripple-marks, or the furrows of the runnels, which during the recess of the tides had worked their pigmy gorges in the sand.

As the breath of the primeval winds passed over the primeval shores, it ruffled gently up the fine sandy mud, which, hardening in the sun or drying in the wind when the waters receded, was, on their return, covered up by a coating of fine silt. Each succeeding tide added layer to layer, and thus, by the gentle and successive deposit of films of mud, the records of the most evanescent meteorological phenomena have been retained and preserved.

Thus have been preserved the ripple-marks; and from them, moreover, we learn the direction and force of the wind that formed them. The particles of matter moved by its power would travel up the longest incline of the ripple-mound, and fall down by its own momentum on the steepest slope; and, as on our present shores, it will be seen that the general trend of the ripple-mounds and -furrows is at right angles to the point from whence the wind blows; by the converse of the rule, a straight line drawn at right angles to the trend of the fossil ripple-marks must point to the quarter whence the breeze which formed it issued.

In the same manner, by successive covering by pellicles of fresh mud, have the sun-cracks, the rain-drops, and the worm-holes been preserved.

In the specimen figured in Plate VII. the rain-drops were much abraded before they were covered up and entombed; the sun-crack shows the drying influences of the wind and sun; while in the hollow spaces where the moisture was retained, the worms perforated by scores the damp earth.

Lign. 2.—SEA-RIPPLES. The arrow indicates the direction of the wind.

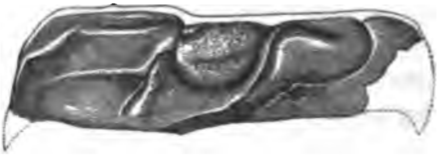
"We may live," says Mr. Binney, "among the grandest scenes of nature, or may visit the noblest monuments of art, and remain insensible to their beauty or sublimity. Differently affected, we may find in the barren sands of the sea-shore enjoyment of the purest character, and speculations which, rising from nothing more important than the trail of a sea-slug, will lead us to contemplate, and in some measure to comprehend, some of the most extensive operations of nature, and bring under review unnumbered ages, past, present, and to come."

The Arenicolæ construct no tubes on the surface of marine objects, they have no protecting cases nor shells, no solid skeletons, but their soft, ring-formed bodies, supporting on each segment tufts of bristle-feet, and feathery, vein-like, external lungs, lie buried in the sand, and there, by means of their terminal retractile proboscis, unarmed by teeth, these sightless beings suck in the watery sand, or ooze, and obtain their nutriment in the organic particles it contains. Dying, they leave nought but their burrows and their trails; of themselves, nothing.

These old fossil worm-holes of the Longmynds are much smaller than the recent ones of the common *Arenicola piscatorum;* and in all cases that I have seen, there is in them an absence of those coils of sands at the vent-ends of the burrows, and of the conical cavities at the other extremities, which, everywhere on our sea-sands and shores, mark the existence below of the innumerable thousands of the fisherman's bait. We have noticed this last point not from any desire to invalidate Mr. Salter's determination, but for the purpose of drawing attention to a class of holes which appear to have been hitherto totally disregarded by palæontologists,—I mean those made by the long siphons of many of the mollusca. I have frequently detected great colonies of Tellens, and other such shells, by the double proximate holes formed by their long, slender, siphonal tubes, and the inhalent and exhalent currents of water which pass to or from them.

Mr. Hancock has recently shown many so-called fossil worms and worm-tracks to be the trails of crustacea, and I think at least some of the now-considered Arenicolites and worm-burrows will ultimately be attributed to some of the mollusca associated with them in the same beds.

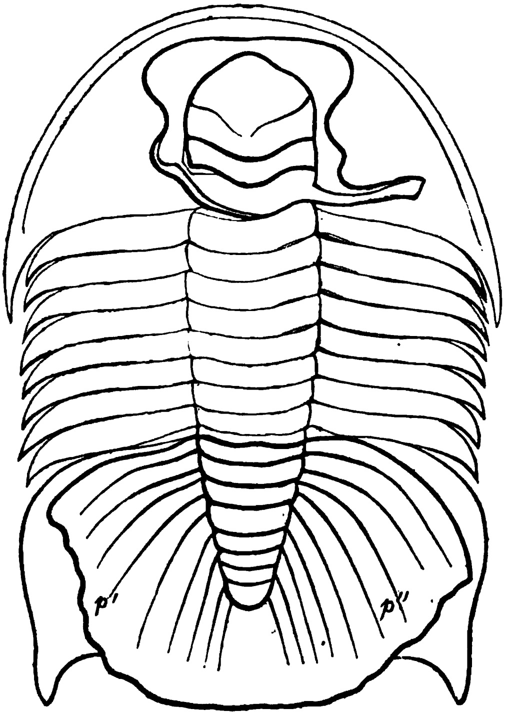
The most remarkable of the Church Stretton fossils, however, are the few fragments of a Trilobite, called by Mr. Salter *Palæopyge Ramsayi*, and allied to the *Dikelocephalus Minnesotensis* described by Dr. Dale Owen, from the Minnesota Territory, United States. The most intelligible of these fragments is a portion of the pygidium, or caudal extremity, 2¼ inches broad, and ⅝ths of an inch long, the equivalent of the part marked *p′*, *p″*, of the American Dikelocephalus, fig. 4, p. 189.



Lign. 3.—Pygidium of Trilobite, *Palæopyge Ramsayi*, Salter.
From Callow Hill, Little Stretton. (From Plate IV. vol. xii. Quart. Journ. Geol. Soc.)

Some obscure traces of sea-weeds, *Chondrites*, have been found also by Mr. Salter at Moel-y-ci, a mountain near Bangor, upon the surface of a coarse sandstone; but these remains are too imperfect for an exact description. And two species of Palæorchorda and two of Chondrites have been also described by Professor MacCoy from the Skiddaw slates. But with these exceptions, the only other locality in which Cambrian fossils have been found is Bray Head, in the county of Wicklow. It was there, however, nine years before Mr. Salter's discoveries in Shropshire, that the first relics of a primordial organized life were found by Dr. Kinahan.

Of those fossils doubtfully an animal or a plant, we are as yet only acquainted with one genus; one species, the *Oldhamia radiata*,* I have already figured in Vol. I. (*see Frontispiece*) in connexion with these papers. The other, and common form—for in these old Irish schists they exist in myriads, the scaling surfaces of the rocks bein completely bespattered with their elegant forms—I now present to my readers in Plate VIII.



Lign. 4.—Dikelocephalus Minnesotensis. (Two-thirds nat. size.) From the Lowest Sandstones, at Stillwater, Minnesota. (Reduced from the figure in Dr. Dale Owen's "Geological Report of Wisconsin, Iowa, and Minnesota.")

---

* Lately another peculiar and obscure form has been found, *Haughtonia*.

These Oldhamiæ are supposed to be related to the horny zoophytes (Hydroid polyps), such as the Sertularia, and the other flexible, feathery, horny corals, which, drifted ashore by the waves, are blown about on our beaches. In each of the cells of these horny Sertularian polypidoms, when living, was an animal possessed of numerous tentacles, and of a simple stomach-sac. Each was connected by a common stem to the others, so that each polypidom would be regarded as either a living animal mass with numerous heads, or, more properly, as a connected colony of individuals never completely separated from their parents, out of which, like the branches of a vegetable, they budded and grew.

Some have thought these Oldhamiæ to have been animals allied to the flexible branching Bryozoans, such as our common *Salicornaria farciminoides*, which has a more highly organized system of digestive organs.

Thus, if our first traces of it are to be depended upon, organic life has not begun with the lowest grades, nor with the highest. In the sediments of those first sea-washed shores, it is not the shapeless sponge, which, without locomotive capacity, lazily imbibed the briny fluid by one set of pores to drive it out in streams from others, nor the simple foraminifer, whose traces of existence we find; nor was it man, of highest organization, who has left his footprints upon those first silent shores. The ancient lug-worm, formed of rings, and not abhorrent, like the earth-worm, in its red and unctuous look, but radiant with gay colours, and beautiful to look at, like the sea-worms and nereides of our shores; and, from their food consisting of decaying vegetable and animal matter, indicating therefore the existence then of sea-weeds, or of the minuter forms of animal life—the Sertulian zoophytes, ever and anon protruding their beautiful circles of hyaline and feathery tentacles, grasping their tiny, almost microscopic prey,—and the crustaceous Trilobite, all well developed and by no means simple forms of animal construction. These, and simple but largish sea-weeds, are the first fossils the most searching inquiries have as yet discovered, and, as far as we yet know, these were all that lived or grew on those primeval shores, on which nor waves nor ripples landed the glittering fish; for, as far as we yet know, the wide expanse of ocean waters was then untenanted by the scaly tribe.

And now I would say a few words why it is believed that these are the first traces of organized life upon our planet.

While in Europe generally the older strata are much broken up and metamorphosed over some large tracts, they are still in others but very little altered from their original condition of sediments; and certainly not more so than the newer, though still vastly ancient, Silurian fossiliferous deposits which succeeded them. For a thousand miles around New York, such ancient primitive strata stretch in a nearly level and unchanged condition; and in Russia, vast plains and low hill-regions are similarly unaltered, until, in their range towards the igneous eruptive masses of the Urals, they become crystalline and metamorphosed.

In our own land, the old Cambrian rocks are not more altered in structural character than the Silurian beds above them, in which fossils are abundantly found. There is, therefore, no physical obstruction to the preservation in the fossilized state of the living creatures and plants of the primeval lands or seas.

We should bear in mind, however, that of these old rocks we have as yet but scanty knowledge; that there are abroad, both in Europe and America, great masses of unfossiliferous rock underlying the Silurian strata which have never been searched for organic remains; and that even in our typical region, the Longmynd, there are Cambrian strata, both above and below the fossiliferous bands, in which as yet nothing has been found, and therefore we may still hope to obtain further and more correct evidence of the fauna and flora of that vastly remote era.

We have then, in mental vision, looked through the long vista of past ages, to see the first-born lands of our mother-earth joyously basking in the smiles of the sun, bathed in the tear-drops of the clouds, and scarred with the blasts of the waves and the storms. We have looked back, at least, to perceive a world governed by the same natural laws as our own. But how little, after all, do we know of that primitive world! How hard, through the mists and obscurities of myriad ages, to trace out any of its features! As a babe unfolding its eyes to the day stares vacantly around, so the most gigantic mind first gazes, by God's will mercifully, on the first aspect of creation.

Like that of the child, day by day the mind of the student acquires strength, until at last it grasps within its own capacity the whole expanse, and bravely treads in fields unknown, undaunted, undeterred; at every stride becoming more and more reverently and devoutly impressed with the mysterious powers and attributes of our great Eternal Father.

We have spoken all that is known of the first world and its inhabitants, and these are the legends of the Bottom-rocks. In one of the sweet tales bequeathed to us by our Saxon forefathers of the Venerable Bede, we are told that a boy in mockery once led the venerable old man, when blind with age, into a vale "that lay all thickly sowed with mighty rocks," and in mischief told him "many men wanted to hear him." Eloquently and long the gentle preacher expounded on the wonderful ways and goodness of God, until "the tears ran down his hoary beard," and "when at the close, as seemeth always meet, he prayed 'OUR FATHER,' and pronounced aloud

'Thine is the kingdom, and the power, THINE
The glory now and through eternity,'

"at once there rang through all the echoing vale a sound of many thousand voices, crying, Amen! most reverend sire, Amen! Amen!"

Truly, from the primeval rocks rings out the universal response, echoed and re-echoed from innumerable world-clusters, and from every portion of illimitable space through which the Creative Energy has passed in its eternal and ever-expanding progress, THINE is the kingdom, the power, and the glory. Amen, Amen.

NOTICE OF THE OCCURRENCE IN FLINTS OF SMALL SILICEOUS NODULAR CONCRETIONS, CONTAINING DIFFERENT SPECIES OF FORAMINIFERA.

By N. T. Wetherell, Esq., M.R.C.S.

I have often observed in flints from the gravel-pits in the vicinity of Highgate, and at Finchley, Whetstone, and Muswell-hill, small rounded bodies, about the size of a pea. When the flints are fractured, these bodies are generally broken across, and in some instances I have found them to contain Foraminifera.[*]

Figs. 1 2 3 4 5

Explanation of Figures.

Fig. 1.—Section of a flint with *Cristellaria rotulata*. *a*. Specimen not surrounded by a pea-like concretion. *b*. Specimen surrounded by a nodular body.—Whetstone gravel-pit.

„ 2.—Portion of a flint with two nodular bodies having hollow centres; the fossils forming the nuclei having disappeared.—Muswell-hill.

„ 3.—Portion of a flint having externally nodular bodies with Foraminifera in their centres.—Finchley.

„ 4.—Portion of a flint with a smooth surface, on which is visible a water-worn nodular body exposing a Foraminifer in the middle.

„ 5.—Portion of broken flint with numerous sections of minute nodular bodies.—Whetstone.

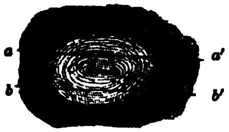


Fig. 6.

As yet, I have only seen one fossil in the centre of each of these small nodules, and I think it is probable that the major part, if not all, of them have an organic centre, although many, when broken, do not exhibit the nucleus. This, I consider, can be explained as follows:—The nodule may be fractured above the centre, as along the line *a a′*, fig. 6; or below, as at *b b′*. In either of these cases, the fossil, *c*, in the centre, which in general is very small, would not be visible. Again, it is a well-known fact, that many organic remains in flint have been removed by natural causes, leaving very little or no trace of their former existence, so that, in this latter instance, the centre may be exposed without any of the original organic structure being discoverable. There is an interesting specimen, from Muswell-hill, fig. 2, having two of the nodules with the centres hollowed out; the fossils having thus disappeared.

---

[*] Mr. T. Rupert Jones has, with his usual kindness, given me the names of several of the species—*Cristellaria rotulata*, *Nodosaria zippei*, *Lituola nautiloidea*, *L. irregularis*, &c. N. T. W.

These small concretionary bodies are in most flints very easily detected, from their having usually a very different aspect and colour from the flint which surrounds them. Different specimens vary in thickness, and some are opaque, others semi-transparent.

On looking over a gravel-heap, flints are occasionally met with having rough and irregular external surfaces. On such surfaces I have detected many of the pea-like concretions above alluded to. These have generally the upper or most exposed part flattened from attrition, and occasionally the concretions are so much water-worn as to expose the fossil in their centres. Sometimes these small bodies are found partly rubbed down on the flints with a smooth exterior. Although I have drawn particular attention to the fact that many of these bodies are of the size of a pea, I should observe that much larger, as also very minute, examples occur. They vary also in shape from spherical to oviform and subcylindrical.

I am induced to make this communication, as it bears upon the subjects noticed in my two recent papers read before the Geological Society respecting the organic centres of the nodular concretions in the London clay, and on the origin of the structure of some banded flints.

A CHAPTER ON FOSSIL LIGHTNING.

By G. D. Gibb, M.D., M.A., F.G.S., Member of the Canadian Institute.

The expression "fossil lightning" may seem somewhat paradoxical, but it is here employed in a figurative sense to designate a condition of things which we have good modern evidence to prove to have been the result of the lightning's flash, myriads of ages gone by. Of late years vitrified sand-tubes have been discovered in Cumberland, in Prussia, South America, Natal, and other places; and these have been very clearly made out as having been directly caused by lightning, and hence they have been called by mineralogists "Fulminary tubes" or Fulgurites. All these would appear, so far as we can ascertain, to have been formed at comparatively a very recent period, and hardly, therefore, deserving of the appellation of "fossil lightning." Nevertheless, as I have come across some examples of such bodies on the surface of the flagstones which form our pavements, and of the antiquity of which there cannot be any doubt whatever, I have no hesitation in making use of the term which heads this chapter.

If I had at one time any scruples upon this point, they were removed whilst attending the instructive lectures so eloquently delivered by that great philosopher and distinguished comparative anatomist, Professor Owen, at the Museum of Practical Geology, in the early part of the last year. He used this expression, in his first lecture on Fossil Birds, when particularly speaking of the various modes in which the evidences of evanescent things become recognisably preserved in rock, as illustrated by meteoric phenomena, footprints, soft and soluble plants, and animals. The "fossil lightning," as exhibited in the British Museum, he lucidly described, and pronounced some of it even to be forked. As further illustrating evanescence, I may for the moment refer to some specimens of rain-prints and shrinkage-cracks on the under side of layers of carboniferous sandstone from Cape Breton (Nova Scotia), figured and described by Sir Charles Lyell, in the Geological Society's Journal and in his "Manual of Geology." The large size of the rain-drops would indicate most probably a violent shower, lasting but a short period of time, and followed by a gleam of sunshine which was powerful enough to produce a rapid drying of the sand, and the formation of shrinkage-cracks, which, together with the depressions formed by the rain-drops, the latter often so strikingly marked as to indicate the very direction of the shower, became covered by a thin layer of sand on the next flowing of the tide. The shrinkage-cracks and the large drops of rain I have heard described as instances of *fossil sunshine.*

Fulgurites were first discovered by the shepherd Herman in 1711, whose specimens are still preserved in the Museum at Dresden; Hentzen next found them, in 1805, and he was the first to recognise their true nature. They are generally compressed in form, mostly hollow, and taper in their descent into the sand vertically. Some are distinctly furcated, and in many specimens lateral branches, also tubular and from two to three inches long, and not exceeding a quarter of an inch at the point of junction, proceed from various parts of the parent tube. These small branches gradually bend downwards, and assume a more or less conical form, terminating in abrupt and closed points. If the lightning has encountered the resistance of pebbles, or has passed through wet sand, the tube becomes not only contorted and twisted in its course, but is also much flattened and compressed. Mr. Irton found a tube at Drigg, which was hollow for eight or nine inches, then became completely solid without any central perforation, while lower down it again assumed the rugged and tubular condition.*

The extreme diameter (or bore (?) of the lightning) of these tubes is an inch and a half;† the internal cavity is rarely circular, being either triangular, quadrangular, pentangular, oval, or some irregular figure; their length, as stated before, is from a few feet to upwards of forty feet; the thickness of their walls has reached $\frac{1}{10}$th of an inch, and their largest circumference from two to five inches, as I have determined by actual measurement.

Nearly all the tubes met with have numerous longitudinal furrows and indentations on their external surface, and have not inaptly been compared to a shrivelled vegetable stalk, or the bark of certain trees, particularly the elm, the birch, and the cork. These furrows and creases are considered to be the result of the compression of the surrounding loose sand, while the tube was still softened from the effects of the intense heat. Perfectly cylindrical fragments, free from furrows, have, however, been discovered, with a circumference of four inches. By the aid of a small magnifying glass, the external surface of the tube is seen to be covered with a crust of agglutinated sand or quartz, each particle being visibly surrounded by vitreous matter, the grains being also round in form, some having a slightly glazed appearance. The internal surface of the tubes is quite smooth and glassy, and completely vitrified, with a corresponding irregularity of form to that of the exterior. Extreme compression acting on the tube in its soft state, has in some cases caused the opposite sides of many of the furrows to come into contact and be welded together; in this way the tube is occasionally so much flattened as to be obliterated. The internal glassy smoothness is brilliant and porcellaneous, and resembles many mineral substances, particularly opal and hyalite.

---

* Trans. Geol. Soc. vols. ii. and v.

† The agglutinating power of the electric fluid sometimes forms a mass of 2½ inches diameter, with a tube above and below it; many such interruptions have been found in the course of a single tube, from the lightning having met with obstacles in its passage.

The colour of these tubes varies according to the nature of the sand into which the lightning has penetrated. Those from Drigg and La Plata are of a light-drab colour, and, if minutely examined, numerous black specks are seen, with what seem to be air-blebs, or perhaps bubbles of steam. It is the white quartzose grains which have become vitrified in all the specimens, imparting to the tube-mass a sufficient amount of hardness to permit the scratching of glass, and even the striking of fire with steel; they are nevertheless easily broken. All the vitrified tubes from Natal are of a dark ferruginous brown colour, owing to impregnation with iron; the largest of these are not quite so dark as the smaller. In certain localities the tubes have been found, firstly on passing through the soil almost black, then yellowish-grey, still lower of greyish-white, and finally colourless; these variations depending upon the purity of the sand from, or its admixture with, other substances. The electric fusion is not solely confined to the less refractory quartz, but in some instances at Drigg has extended to pebbles of hornstone-porphyry, many of which were partly vitrified.

In the foregoing description of "recent lightning," I have confined myself to those tubes which are hollow; but, as I have stated, occasionally this character is wanting, and many of them terminate in the solid state, it is only necessary then to mention that even the vertical penetration is characterised by the same peculiarity; thus of the fulgurites from Natal, very small specimens do not appear to be tubular, but resemble the horizontal cylinders from Dresden.

That the formation of fulgurites, whether recent or fossil, is due to the vitrification of the siliceous matter through which the electric fluid passes, we have clear proofs by our knowledge not only of the meteoric phenomena of the districts in which they are found, but also by the results of various series of experiments which have been from time to time instituted to produce them artificially. In relation to the first, the neighbourhood of the Rio Plata, close to where Mr. Darwin found them, was known to be remarkably subject to electric phenomena; and the sand-hillocks of Drigg, in Cumberland, from presenting themselves as direct objects to clouds coming from the sea, the marshes of Irt only intervening, are favourably situated for promoting electrical discharges. The experiments made seem, too, very conclusive, and are full of interest. The Drigg-sand consists of quartz and hornstone-porphyry, and, when submitted to the action of a powerful blow-pipe, formed a clear glass mingled with olive discolorations resembling the fulgurites.* MM. Hachette, Savart, and Beudant feebly imitated these bodies by the shocks of one of the most powerful galvanic batteries in Paris on powdered quartz, the result being small tubes of an inch in length.† I have experimented upon various kinds of sand with a powerful blowpipe, and have produced glass varying in colour according to the composition of the sand. The majority of light-coloured sands I find to assume a slight rusty colour, on being submitted to a considerable heat, before actual fusion occurs. All these, however, are but feeble evidences of the power of electricity prepared by ourselves, when contrasted with that which constitutes the lightning's flash, the intensity of which can be estimated by the descriptions given of these remarkable bodies. Were any further evidence required to prove these fulgurites to be the result of lightning, it is only necessary to refer to descriptions given of trees struck by the electric fluid, when there have been found at the depth of from twelve to eighteen inches from their roots, melted quartzose matter, and vitrified tubes, of a flattened form with zigzag projections. Our wonder is, that such manifestations of the effects of lightning are really not more commonly noticed than they seem to have been, when we call to mind the observation of Sir Charles Lyell, that "it is probable a moment never passes without a flash of lightning striking some part of the earth."*

---

* Trans. Geol. Soc. vol. ii.

† Annales de Chim. et Phy. tom. 37.

In London, the reader may see fulgurites in the Museum of the Geological Society, including specimens from Drigg, from the shores of La Plata, and from Dresden. In the Museum of Practical Geology, Jermyn Street, are specimens from Natal, many of them larger in size than those from Drigg, as also a tray of small ones. The British Museum contains fulgurites from the Tuarie country, Africa; from the vicinity of Dresden; from the Senner Heide, Westphalia; and from Drigg.

Some of those from Africa are dark in colour, and more nearly resemble those I have seen in a fossil state. The fine state of preservation of most of these has been owing, no doubt, to the soft and dry character of the sand around them.

The evidences of the power of atmospheric electricity are at times made fearfully manifest during thunder-storms, when the electric fluid shatters rocks and scatters immense fragments to considerable distances, splitting and tearing up trees, levelling houses, fissuring thick walls, and melting substances which have been looked upon as infusible. Of the last, we have an illustration according to Saussure in the slaty hornblende on the Dôme du Gouté, one of the summits of Mont Blanc; he found in 1787 vitreous blackish beads, of the size of hemp-seed, which were attributed most clearly to the effects of lightning. Ramond observed the entire face of certain rocks on several summits of the Pyrenees, especially the Pic du Midi and Mont Perdu (the latter upwards of 11,000 feet high), and also the rock Sanadoire, in the Puy de Dôme, varnished with a coating of enamel, and covered with vitreous beads, of the size of peas, the result of the same cause; the interior of the rock being found quite unchanged. On the summit of the Pico del Frayle, the highest pinnacle of the Volcano of Toluca, in Mexico, upwards of 15,000 feet in height, Humboldt noticed the electric effect of lightning. He brought away pieces of a mass of trachyte pierced by lightning, and glazed on the inside like lightning-tubes; in it the lightning had made cylindrical tubes three inches long, in such a manner that the upper and lower openings could be distinguished apart, the rock surrounding these openings being also vitrified. Arago refers to the vitrification of rock (without tubes), which has been seen at a vertical height of 26,650 feet, over an extensive surface, at the Lesser Ararat and other places.* I possess a specimen of rock from Canada, which (being at the present time mislaid, I cannot therefore say positively what it is, but I believe it to be syenite) is thus covered on its exposed surface by a distinct coating of enamel. Several well-attested facts have been collected by Arago, showing the actual vitrification of stones, bricks, and other bodies, by lightning.

---

* Principles of Geology, 8th edition.

To illustrate the immense power of lightning in splitting and moving large masses of rock, I may be permitted to give the following quotation from the MSS. of the Rev. George Low, of Fetlar, in Hibbert's "Shetland Islands:"—

"At Funzie, in Fetlar, about the middle of the last century, a rock of mica-schist, 105 feet long, 10 feet broad, and in some places 4 feet thick, was in an instant torn by a flash of lightning from its bed, and broken into three large and several small fragments. One of these, 26 feet long, 10 feet broad, and 4 feet thick, was simply turned over. The second, which was 28 feet long; 17 broad, and 5 feet in thickness, was hurled across a high point to a distance of 50 yards. Another broken mass, about 40 feet long, was thrown still farther, but in the same direction, quite into the sea. There were also many smaller fragments scattered up and down."

It is in loose sand that we meet with the silicified tubes produced by lightning in the greatest abundance. Almost any substance is liable to be melted that contains even the smallest portion of silex.

My friend, Dr. Bigsby, informs me he has seen, many years ago, what he believes to be the effects of lightning in the chalk near Carisbrook, Isle of Wight. These consisted of tubes, perpendicular to the surface, which were vitrified and glassy in their interior, and the chalk itself affected for a short distance around them. They were quite or nearly straight; in size, from half an inch to an inch in diameter, and were exposed in a fissure of the chalk. About three feet of these tubes were visible, and then they became lost.

---

* Humboldt's Cosmos, vol. i. and vol. iv.

The finest examples of these lightning-tubes which have come under my notice in the London museums are those from Drigg, in Cumberland, in the Museum of the Geological Society, and which have been described in that Society's Transactions. They appear to be the most perfect, although larger tubes have been found at Natal. In speaking of these I shall combine a general description of the whole.

It is in banks, hillocks, or mounds of loose sand, that they are generally met with, sometimes, however, in immense hollows, or occasionally on declivities of mounds of sand. At Drigg they were discovered in the middle of sand-banks forty feet high, between the river Irt and the sea, but projecting above the surface from the drifting away of the sand. These sand-banks are exceeded both in extent and height by those at Eskmeols, in the same county. On the shores of La Plata, in South America, Mr. Darwin found them in the sand-hillocks of Moldonado, which were constantly changing their position from not being protected by vegetation. This circumstance caused them to be found projecting above the surface, as at Drigg, and Mr. Darwin inferred, from finding numerous fragments lying about, that they had at one time been buried at a greater depth.[*] These occurred in a level area of shifting sand, situated among some high sand-hillocks, distant about half a mile from a chain of hills 400 and 500 feet high. In the Senne, Westphalia, similar tubes were found on the declivities of mounds of sand thirty feet high; but occasionally some were noticed in cavities, described as hollowed out in the heath in the form of great bowls, 200 feet in circumference, with a depth of from twelve to fifteen feet.

The position in which these tubes are found is one of some interest and importance. As usually encountered, they run vertically into the sand, at a varying depth. On the banks of La Plata four sets entered the sand perpendicularly, and one was traced 5½ feet into the sand by Mr. Darwin; but, as the diameter of the whole was nearly equal, it must have extended to a greater depth. He found one deviating from a right line at a considerable bend, amounting to 33°; and from this tube two small branches about a foot apart were sent off, one pointing downwards and the other upwards. This is an illustration of the forked character of the electric fluid, which, besides its division into two branches, would seem to have turned back in this case at an acute angle of 26° to the line of its main course. At Drigg many tubes were found dividing into two branches and pursuing a tortuous course into the sand. Some of the tubes gave off several small branches, the diameter of which was not a fifth of the tube whence they sprang; others, again, deviated almost at right angles, glancing off, as it seemed, by the interruption of a pebble, as in the example figured in the Geological Society's Transactions (vol. v. First Series, pl. 3).

---

[*] Darwin's Journal, vol. iii. 1839, p. 69.

It is looked upon as a fact somewhat remarkable, that quite a number of tubes have been discovered to enter the surface of these sand-hills in comparatively limited areas; at least, such was the case at Drigg, on the shores of La Plata, and also in Germany. Mr. Darwin counted more than four within a space of sixty yards by twenty. Three were noticed within an area of fifteen yards, upon a single hillock at Drigg; and the same number were found in an equally limited space in Germany, as described by M. Ribbentrop. In considering this peculiarity, Mr. Darwin believes in the improbability of these tubes being produced by successive and distinct shocks—an opinion in which most persons will concur. Yet, whilst acknowledging the possibility of a division of the lightning into separate branches shortly before entering the ground, as suggested by him, I still think that the electric fluid may have run along the surface of the sand, and then entered it at different spots remotely situated from one another. This view is by no means irrational, when we reflect upon the truly singular peculiarities associated with this wonderful fluid, which may be seen at times to run along the surface of bodies and suddenly disappear. The intensity of its action, too, is oftentimes modified by the amount of resistance offered by substances struck by it. On the other hand, the electric fluid may divide into several distinct currents, which would enter the surface at the distance of many yards from each other.

The greatest depth to which the electric fluid has penetrated vertically, as demonstrated at Drigg, is forty feet; but I should be disposed to estimate the length of horizontal fusion at a much greater amount.

The majority of the fulgurites which I have had the opportunity of examining, have entered the sand vertically; but some, again, ran along the surface of the sand in a horizontal direction. And it is this latter form only that we can expect to meet with in a fossil state. As examples of horizontal recent tubes, I may refer to specimens from Dresden, in the British Museum and in the Museum of the Geological Society. In the former collection the tube is very small, and runs in a somewhat tortuous manner, giving off a small branch five inches long, the entire length being sixteen feet and two-thirds; but the original must have been very much longer, as this is but a portion of it. This example was presented by Dr. Fiedler, who has published a work on fulgurites in German, to which I have not had access; but was obtained "on the confines of Holland, in a sandy country; a shepherd, after having seen the lightning strike a hillock of sand, found, in the very point where it struck, a fulgurite." The Geological Society's specimen is eighteen inches long, and as large as a lead-pencil. Both of these examples are solid, without any internal cavity, and it seems a question in my mind whether actual tubes are ever found in any other than a vertical position. The examples in a fossil state which have come across my notice, and which first drew my attention to the subject, appear to have been found only in the solid form,* and partaking of the horizontal position. There are three flagstones on the eastern side of Tottenham Court Road which contain fulgurites of a lightish colour, running in forked directions. There is one on the eastern side of Russell Square, close to Guildford Street, on the surface of which a dark ferruginous tube of "fossil lightning" runs diagonally across the stone, its diameter being about two lines. I have noticed them in three or four other places in the same parish, and feel satisfied they are the actual results of lightning: and whilst preparing this paper, I have come across a flagstone on the northern side of the Marylebone Road, running on the south side of Park Square, Regent's Park (two-thirds of the way towards the eastern end of the square), which contains one of the finest examples I have yet seen. The age of these flags I am unable to determine;* but at any rate, by thus drawing attention to the subject, I hope it will lead to the discovery and preservation of fossil specimens, even in the oldest sandstones, for there is no reason to doubt the existence of electrical influences at the very earliest ages of our planet.

---

* I state this with some reservation, because I have seen a section of what looks like a lightning-tube in a sandstone door-step. It has four irregularly compressed sides, and presents very much the appearance of one of these bodies.

LOCALITIES OF FULGURITES.

Britain.—Fossil in sandstone flags	Dr. Gibb.
Drigg, Cumberland	Mr. E. L. Irton.
Eskmeals, in larger sand-banks near the same place†.	Mr. Richd. Falcon.
Lancashire, coasts of	Greg and Lettsom.
Carisbrook, Isle of Wight	Dr. Bigsby.
Dover, Chalk Cliffs ‡	Mr. S. J. Mackie.
Germany	M. Ribbentrop.
Massel, Silesia	Herman.
La Senne, Heath of Paderbarn, Westphalia	Dr. Hentzen.
Nietleben, near Halle on the Saale.	
Regenstein, near Blankenburg.	
Pillau, near Königsberg, Eastern Prussia.	
Dresden, vicinity of	Dr. H. K. Fiedler.
Tuarik Country, Africa.	
Natal do.	
Lake of Two Mountains, Canada §.	Dr. Gibb.
Pinnacle of Toluca, Mexico	Humboldt.
Maldonado, Rio de la Plata	Mr. Darwin.
Bahia, Brazil.	

---

* These flagstones are probably from the lower carboniferous rocks of Yorkshire; at least, nearly all London is paved with such flags.—Ed. Geol.

† Near this spot are the remains of an old Roman encampment; and occasionally coins, with other objects of interest, are turned up.

‡ This instance referred to by Dr. Gibb was a case of a double or furcated perforation in a thick layer of clay covering the Castle Hill at Dover, made by a powerful stream of lightning, which, when a lad, I saw strike the ground at an elevated point. It can scarcely be called a fulgurite, as the clay was only coated on the surface with bluish-grey beads and grains, powdered, as it were, like the bloom of a peach. The perforations forked at about nine inches from the upper surface of the soil, apparently divided by one of the numerous angular fragments of flint which abound in the subsoil, and were of sufficient dimensions for me to put my arm with my walking-stick into them. The branches had divergent directions, as nearly as I can remember, of 30° or 35° on either hand from an imaginary intermediate vertical line. Their forms were irregularly angular, with ridges, as in the fulgurites, but they were of far larger diameter than any of the latter objects I have ever seen.D—S. J. M.

§ When strolling over the sand-banks of the hills at this place, when a youth, I discovered substances which I now believe were these tubes.

FOREIGN CORRESPONDENCE.

By Dr. T. L. Phipson, of Paris.

Earthquake at Pavia—A Lesson to Astronomers—Supposed Relation between Earthquakes and the Phases of the Moon—Descloizeaux on the Optical Properties of Crystals—Delesse on Metamorphism by Granite-Rocks.

A letter to the editor of the *Corrispondenza Scientifica in Roma*, by Sig. Zantedeschi, dated 20th January, 1859, informs us that on that day, at fifty-seven minutes past eight in the morning, three shocks of an earthquake were felt at Pavia. The undulatory movement of the ground was very great. Various objects in the houses were set in motion, bells were rung, doors burst open, &c. The duration of the phenomenon was about seven seconds. The undulations of the ground were nearly due north and south. The pendulum of a clock belonging to Sig. Zantedeschi, which oscillates from north to south, was not stopped by the earthquake; but the clocks of the observatory, the pendulums of which oscillate east and west, were all stopped. This is a timely warning to astronomers, in countries where earthquakes are common phenomena. It is of no little importance that the pendulums of clocks belonging to astronomical observatories should be placed in such a manner that they may oscillate in different directions; so that, if a sudden commotion of the earth take place, one or two clocks at most will be stopped by the undulations of the ground.

At Pavia, during the earthquake of which we speak, the atmosphere was calm and the sky serene. The moon was full on the 18th, two days before the earthquake. This is another observation to be added to those already collected by M. Perrey, of Dijon, with a view of proving that earthquakes are more frequent at the periods of the new and full moon than at the quadratures. According to M. Perrey, the greatest tides of the internal liquid mass of the globe must correspond with those of the waters on the surface of the earth. Apropos of this, Madame Caterina Scarpellini, who is at present occupied with meteorological observations on the Capitol at Rome, has attentively observed earthquakes throughout the year 1858, and writes to M. Elie de Beaumont that her observations, as far as they go, confirm the idea brought forward by M. Perrey, that there exists a certain relation between these phenomena and the phases of the moon. The question of the "internal liquid mass" of the globe we feel inclined to leave alone for the present.

M. Descloizeaux, a distinguished mineralogist of Paris, who won himself some reputation by his geological mission to Iceland, has been studying for a long time the optical properties of crystals. He has lately addressed to the Academy of Sciences a new memoir on this subject, and hopes soon to have completed his numerous observations on double refraction, principal axes of refraction, their number, position, and relations to the optical axes, the laws of dispersion, &c., in transparent minerals. It appears that the number of transparent substances in the mineral world, including those which are transparent enough when taken in thin laminæ to give passage to a ray of light, is about 180. Of these, 166, of which eighty-one have one axis, and eighty-five two axes, have been completely studied by M. Descloizeaux. Twelve alone remain of which the optical co-efficients are not yet satisfactorily determined.

We have alluded in former papers to the action of metamorphism by eruptive rocks on combustibles (lignite, coal, &c.), also to the action of lava and trap-rocks on limestones, argillaceous strata, and sandstones. We have now before us a new memoir by M. Delesse, in which granite is the eruptive rock under consideration.

When metamorphism is studied with respect to granite-rocks it is seen that their effects differ notably from those produced by the different varieties of trap. The following are the characters presented by strata that have undergone metamorphism by contact with granite. If the rock acted upon be *limestone*, it often happens that it has not been modified at all, even where it has been penetrated, or even where it has been covered over, by granite. The glauconite, so frequent in calcareous strata, remains also unaltered. More frequently, however, the structure of the calcareous rock has become *crystalline*, and of a paler colour, having passed into saccharoid limestone. If the limestone be argillaceous, it has become very compact and lithoid, but not silicified. In some cases it has become cavernous, but has not passed into dolomite; oftentimes, indeed, it contains less magnesia where it is in immediate contact with the upheaved granite. Among the minerals that have been developed in limestone under these circumstances, we must name more especially spathic carbonates, quartz, and minerals common in metallic lodes. The latter form serpentine veins in the metamorphosed rock, or line some of its cavities.

When a *siliceous* rock has been upheaved by granite, we observe that the metamorphism has been equally irregular; sometimes completely null; sometimes so complete that the whole rock has been transformed into transparent quartz. Quartz must in this case be noted as the most important mineral developed in immediate contact with granite. Next comes sulphate of baryta, with which the quartz is often associated, fluor-spar, and the minerals of metallic lodes.

When the rock modified by granite is *argillaceous*, its structure has become schistose or lithoid. In some cases this structure approaches to that of jasper; but it has not been observed to have taken a vitreous aspect (as if quartz had been formed). When the argillaceous

ck contains carbonate of lime, its structure has become sometimes
llular or amygdaloïd.

Rocks or strata metamorphosed by granite are not observed to con-
in zeolites ; as we have before remarked is the case with strata in
ontact with lava or trap-rock ; but they often contain tourmaline
nd the minerals which generally accompany the latter. Numerous
inerals are developed, however, by contact with granite, especially
hen the metamorphosed rock is argillaceous. Some of the most
requent are mica, macle, staurotide, disthene, dipyre, garnet, horn-
lende, graphite, and spinelle. These minerals, although formed in-
ontestably by the metamorphic action of granite, do not owe their
xistence to the immediate contact of the eruptive rock. M. Delesse
supposes them to have been formed in a certain zone around the granite at the moment the granite itself became crystalline. He refers them to his "normal metamorphisms," which we described in one of our previous papers ; and he remarks that the metamorphic effects of granite extend to great distances, as *normal metamorphism*, but, that, as phenomena of *immediate contact*, they are very much more limited than we have hitherto been led to suppose.

We have thus terminated our rapid sketch of the effects produced on the different stratified deposits by the upheaval of igneous or plutonic rocks. In a future article we will glance at the other side of the question—the action that the different strata have exercised upon the rocks that have uplifted them and modified their structure and composition.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—*March 23d*, 1859.—Prof. J. Phillips, President, in the chair.

The following communications were read :—

1. "On some Amphibian and Reptilian Remains from South Africa and Australia." By Thomas H. Huxley, F.R.S., Sec. G. S., Prof. of Natural History, Government School of Mines.

The author described in the first place the remains of a small Labyrinthodont, Amphibian, which he proposed to call *Micropholis Stowii*. The fossil was discovered by Mr. Stow, and accompanied that gentleman's paper "On some Fossils from South Africa," read before the Society on the 17th of November last, on which occasion Prof. Huxley expressed the opinion that it would prove to be an Amphibian, and probably a Labyrinthodont.

It had been found impossible to work out the back part of the skull, so as to exhibit the occipital condyles, but the characters of the few cranial bones which remain, of the teeth, and of the lower jaw, and the traces of a largely developed hyoidean apparatus, afforded sufficiently convincing evidence of the affinities of *Micropholis*.

The generic appellation is based on the occurrence of numerous minute polygonal bony scutes on the integument of the under surface of the head; in which character *Micropholis* has a remote resemblance to *Archegosaurus*. The scutes, however, are very different in their aspect from those of the last-named genus.

Micropholis has little resemblance with any European Labyrinthodonts, except *Metopias*, and the singular so-called "*Labyrinthodon Bucklandi*," from the Trias of Warwickshire, to the peculiarities of which the author alluded, proposing to consider it as the type of a new genus, which might be termed "*Dasyceps*."

On the other hand, there are two southern forms of Labyrinthodonts, which exhibit many similarities to *Micropholis*. These are the *Brachyops laticeps* of Prof. Owen, from Central India, and a new form allied to *Brachyops*, but distinct from it, from Australia. This last was described and named *Bothriceps Australis*.

The author stated that he was not prepared to draw any very decided conclusion as to the age of the Karoo- or Dicynodon-beds, from the fact of the occurrence of Labyrinthodont *Amphibia* in them, inasmuch as the Labyrinthodonts range from the Lower Lias to the Carboniferous Formation inclusive; and *Micropholis* is unlike any of the Labyrinthodonts whose precise age is known.

The fragmentary remains of a young reptile, which were found associated with *Micropholis*, were stated by Prof. Huxley to be undoubtedly those of a *Dicynodon*. Of this, however, and of a small Dicynodont skull from the same locality, he promised to speak on a future occasion.

The second part of the paper consisted of a description of the structure of the cranium, of the sclerotic ring, of a fragmentary sacrum, and of the humerus of the new species of *Dicynodon* (*D. Murrayi*) from near Colesberg, which was characterised at a previous meeting of the Society (February 23). Particular attention was directed to the unusually complete ossification of the cranio-facial axis, and to the striking resemblance in the structure of the bony walls of the olfactory apparatus to that which obtains in Birds. Prof. Huxley, in conclusion, gave a sketch of the general proportions of the *Dicynodon*, so far as the evidence yet obtained allows a judgment to be formed, and particularly alluded to the existence of a long series of caudal vertebræ. Specimens of the fossil-wood found with the remains of *D. Murrayi* had been submitted to Dr. Hooker, and declared by him to be coniferous.

2. "On *Rhamphorhynchus Bucklandi*, a Pterosaurian from the Stonesfield Slate." By Thomas H. Huxley, F.R.S., Sec. G. S., Prof. of Natural History, Government School of Mines.

The author based his account of this Pterosaurian upon a fine fragment of a lower jaw, discovered by the Earl of Ducie in the quarries of Sarsden, near Chipping Norton,—on a coracoid bone from the Stonesfield slate, in the collection of the Museum of Practical Geology,—on a large fragment of a lower jaw in the Museum of the Society, and a very fine specimen of a lower jaw in the Museum of the College of Surgeons. The ascription of the coracoid to the same species as that to which the jaws belong was admitted to be hypothetical, but their proportions agree sufficiently well to give probability to the supposition. Furthermore, the author did not suppose it to be absolutely demonstrable that the jaws and coracoid in question, supposing them to be of one species, were of the same species as those Pterosaurian remains discovered by Dr. Buckland in the Stonesfield slate many years ago, and (though never described) named after him *Pterodactylus Bucklandi;* but, as a specific name unaccompanied by a description is of no authority, and as there is no evidence of the existence of more than one species of Pterosaurian in the Stonesfield slate, it seemed that the adoption of the specific name *Bucklandi* would have the least tendency to create confusion.

These remains prove that the Stonesfield Pterosaurian belonged to the genus *Rhamphorhynchus* of Von Meyer, and that it had nearly twice the size of the liassic *Dimorphodon macronyx*. The mandible of *R. Bucklandi* is remarkable for its stoutness and the depth of its rami towards the symphysis, which is short and produced into a stout curved median edentulous rostrum. The teeth are similar in form, flattened and sharp-pointed, distinct, and not more than seven in number on each side: the last tooth is situated rather behind the junction of the middle with the posterior third of the jaw. The author took occasion to refer incidentally to some undescribed peculiarities in the structure of the coracoid of *Dimorphodon macronyx.*

3. "On a Fossil Bird and a Fossil Cetacean from New Zealand." By Thomas H. Huxley, F.R.S., Sec. G.S., Prof. of Natural History, Government School of Mines.

These remains were, the right tarso-metatarsal bone of a member of the Penguin family, allied to *Eudyptes*, but indicating a bird of much larger size than any living species of that genus, larger indeed than even the largest *Aptenodytes*, and to which the name of *Palæudyptes antarcticus* was given,—and the left humerus of a small cetacean, more nearly resembling that of the common Porpoise than that of any other member of the order (*Balæna, Balænoptera, Monodon, Delphinus, Orca, Hyperoodon*) with which the author had been able to compare it. Nevertheless, as there are very marked differences between the fossil humerus and that of *Phocæna*, Prof. Huxley named the species *Phocænopsis Mantelli.* Mr. W. Mantell, F.G.S., to whom the author was indebted for the opportunity of examining these bones, stated that the beds whence they were obtained were certainly of Tertiary age, and of much earlier date than the epoch of the *Dinornis*, which he considered to have been contemporaneous with man. The *Palæudyptes* was from an older bed than the *Phocænopsis.*

Prof. Huxley drew attention to the remarkable fact that a genus so closely allied to the Penguins which now inhabit New Zealand, and are entirely confined to the Southern Hemisphere, should have existed at so remote an epoch in the same locality.

4. "On the Dermal Armour of *Crocodilus Hastingsiæ.*" By Thomas H. Huxley, F.R.S., Sec. G.S., Prof. of Natural History, Government School of Mines.

The author, after briefly mentioning the very complete armour of articulated dorsal and ventral scutes which he had recently discovered (and described before the Linnæan Society) in two of the three living genera of *Alligatoridæ*, viz. *Caiman* and *Jacare*, showed that similar scutes are found associated with the remains of *Crocodilus Hastingsiæ*, a very fine skull and some scutes of which reptile from Hordwell, kindly lent to Prof. Huxley by Mr. S. Laing, F.G.S., were exhibited. With respect to the suggestion of Prof. Owen, that the *Alligator Hantoniensis* might possibly be a variety of *Crocodilus Hastingsiæ*, the author stated that he had observed in several specimens of the recent *Crocodilus palustris*, which by its straight premaxillo-maxillary suture and the general form of its skull most nearly approaches *C. Hastingsiæ*, a tendency to assume the alligator character of a pit, instead of a groove, for the reception of the mandibular canine. Sometimes there is a pit on one side and a groove on the other, and sometimes incomplete pits on both sides in this Crocodile. *Crocodilus Hastingsiæ* still more nearly approaches the *Alligatoridæ* in the number of its teeth and in the characters of the dermal armour now described, so that the probability of its occasionally assuming the Alligatorian dental pits on both sides is greatly increased.

[The foregoing Papers were illustrated by specimens and drawings.]

April 6th, 1859. Prof. J. Phillips, President, in the Chair.—The following communication was read: -

1. "On the Subdivisions of the Inferior Oolite in the South of England, compared with the Equivalent beds of the same formation on the Yorkshire Coast," by Thomas Wright, M.D., F.R.S.E. (Communicated by T. H. Huxley, Esq., Sec. G.S.) With a Note on Dundry Hill, by R. Etheridge, Esq., F.G.S.

The author first remarked that, since the publication of his memoir "On the so-called Sands of the Inferior Oolite" in the Society's Journal (vol. xii. p. 292), some geologists, both in England and on the Continent, had taken the Liassic character of these sands into consideration, and that Oppel, Hébert, and Dewalque had agreed with the author on palæontological grounds; whilst in England Mr. E. Hull (of the Geological Survey) had also adopted his views. On the other hand, Mr. Lycett and Prof. Buckman in their recent memoirs still regard these sands as distinct from the Upper Lias.

Dr. Wright then described the beds at Bluewick, on the Yorkshire coast, which he regards as the equivalents of the "Cephalopoda-bed" or "Jurensis-bed:"

namely, some shales and sandstones underlying the rock which he regards as the basement-bed of the "Dogger" or Inferior Oolite.

These are—1. (uppermost) Shales with *Terebratula trilineata*, *Belemnites compressus*, *B. irregularis*, and *Trigonia Ramsayi*. 2. Sandstone, yellow, with *Turritella*, *Trigonia*, *Astarte*, *Ammonites concavus*, *A. variabilis*, &c. 3. Yellow Sandstone or Serpula-bed. 4. Grey Sandstone or Lingula-bed, with *Lingula Beanii*, *Orbicula*, *Belemnites compressus*, *B. irregularis*, *Ammonites Moorei*, &c.

The author then observed that the Inferior Oolite in the South of England admits of a palæontological subdivision into three zones, having the Fuller's Earth with *Ostrea acuminata* above, and the Cephalopoda-bed with *Ammonites opalinus* beneath:—1st (uppermost), the zone of *Ammonites Parkinsoni*; 2d, zone of *Am. Humphriesianus*; and 3d, zone of *Am. Murchisonæ*. He then described the lowest of these zones, that of *Am. Murchisonæ*, giving as synonyms "Dogger" (part), Young and Bird, and Phillips; "the central and lower division of the Inferior Oolite," Murchison; "Fimbria-stage of the Inferior Oolite," Lycett; "Brauner Jura β," Quenstedt; "Calcaire lædonien" (part), Marcou; "Calcaire à entroques," Cotteau; "die Schichten des Am. Murchisonæ," Oppel. The Leckhampton section was then described, as illustrating this zone, which was also described in its details as seen at Crickley Hill, near Cheltenham, and at Beacon Hill; also at Frocester Hill and Wootton-under-Edge.

The preceding sections exhibit the lithological character and stratigraphical relations of the Pea-grit and Freestones, which, however, undergo great and very important modifications when examined over even a limited area,—the Pea-grit as regards its structure; and the Freestone, its thickness. In the Southern Cotteswolds the Pea-grit loses its pisolitic character; and in the eastern part of the hill district the Freestones thin out and finally disappear; the Inferior Oolite being represented at Stow-on-the-Wold and at Burford by the zone of *Ammonites Parkinsoni*, with its light-coloured ragstones, filled with an abundance of *Clypeus Plotii*, Klein, and forming a "*Clypeus-grit*."

The fossils of the Pea-grit and Freestone, and of the Oolite-marl or Fimbria-bed, were then enumerated. The Oolite-marl was described as having been probably derived from the débris of a Coral-reef: its Nerinæan limestone was particularly alluded to.

The section at the Peak near Robinhood's Bay afforded the author the equivalents of the zones of *Am. Humphriesianus* and *Am. Murchisonæ*, and was described in full.

The zone of *Am. Humphriesianus* was next treated of. Its synonyms are "Inferior Oolite of Dundry Hill," Conybeare and Phillips; "Grey limestone, Bath or Great Oolite" (Yorkshire), Phillips; "Eisenrogenstein (part) und Walk-Erde Gruppe," Fromherz; "Brauner Jura γ und δ," Quenstedt; "Calcaire ferrugineux," Terquem; "Blaue Kalke, Korallenschicht, Giganteus-Thone, und Ostreen-Kalke" (Quenstedt), Pfizenmeyer. The best types of this zone, so well characterised by peculiar Gasteropods and Cephalopods and its ferruginous oolitic grains, are seen in the section at Dundry Hill, at Yeovil and Sherbourne in Somerset, and at Burton-Bradstock and Chideock in Dorset. Just as the thinning-out of the Murchisonæ-zone and the absence of the Humphriesianus-zone near Burford and other localities in the N.E. parts of the Northleach district brings the Parkinsoni-zone nearly into juxtaposition with the clays of the Upper Lias, so the thinning-out of the Murchisonæ-zone at Dundry Hill brings the zone of *Am. Humphriesianus* into close relation with the "Sands of the Upper Lias," and has caused it to be mistaken for the "Cephalopoda-bed" of Frocester and Leckhampton Hills. In the northern Cotteswolds the Humphriesianus-zone is but feebly represented.

The Dundry Hill section was then described in a note by Mr. R. Etheridge, F.G.S., as comprising,—1st (lowest), Lower Lias; 2d, perhaps the "Lias Sands;" 3d, the Shell-bed; 4th, Ammonite-bed (not equivalent to the "Cephalopoda-bed" of the Cotteswolds); 5th to 9th, shelly beds, ragstone, fine-grained oolite, and freestone; some of the latter representing the Parkinsoni-zone.

Dr. Wright then described the section in Gristhorpe Bay, from the Cornbrash to the Millepora-bed;—equal to the zone of *Am. Humphriesianus*. The fossils of these marine and freshwater beds were noted as existing in the cabinets of Leckenby, Bean, and others.

The zone of *Am. Parkinsoni* has the following synonyms, according to the author:—"Trigonia-grit and Gryphite-grit," Murchison and Strickland; "Ragstone and Clypeus-grit," Hull; "Spinosa-stage," Lycett; "Brauner Jura ε" (pars), and "Parkinsonthone, Brauna Jura δ und ε" (pars), Quenstedt; "Calcaire à Polypiers," Terquem; "Die Schichten des Ammonites Parkinsoni," Oppel. This zone is the most persistent of the three subdivisions of the Inferior Oolite, and is its only representative in the south-eastern parts of Gloucestershire.

The sections of Leckhampton Hill, Ravensgate Hill, Cold Comfort, Birdlip Hill, and Rodborough Hill afford the fossils and details illustrative of this zone.

In this communication Dr. Wright endeavoured to show that the Inferior Oolite of the South of England admits of a subdivision into three zones of life, and that each zone is characterised by the presence of Mollusca, Echinodermata, and Corals special to each. 2d. That these three zones are very unequally developed in different regions both in England, France, and Germany; the individual beds composing the zones being sometimes thin and feebly developed (or altogether absent) in some localities, but thick and fully developed in others; the zone of *Am-Murchisonæ* is the one most frequently absent; that of *Am. Humphriesianus* has a wider area; and the zone of *Am. Parkinsoni* is the most persistent, is widely extended, and is very often the sole representative member of the Inferior Oolite formation. 3d. That many *Lamellibranchiata* and a few *Gasteropoda* are common to the three zones, and that most of the *Ammonites*, *Brachiopoda*, *Echinodermata*, and Corals are limited in their range to one of the zones; but that each zone possesses a fauna which is sufficiently characteristic of it. 4th. The Parkinsoni-zone possesses many species of *Mollusca* and *Echinodermata* in common with the Cornbrash; and the Murchisonæ-zone, in like manner, contains many *Lamellibranchiata*, which appeared for the first time in the Jurensis-stage, although all the *Cephalopoda* of these two stages are specifically distinct from each other.

April 20th, 1859.—Major-General Portlock, V.P., in the chair.

The following communications were read:—

1. "On some Reptilian Remains from South Africa." By Professor Owen, F.R.S., F.G.S.

Fam. CROCODILIA. *Galesaurus planiceps*, the Flat-headed Galesaur (from γαλη, polecat, σαυρος, lizard), a genus and species founded on an entire cranium and lower jaw. The skull in length less than twice the breadth, much depressed, and flat above. Occipital region sloping from above backward, divided by a high and sharp ridge from the temporal fossæ, there wide and rhomboidal; orbits small; nostril single and terminal. Dentition, $i\,\frac{4-4}{3-3}$, $c\,\frac{1-1}{1-1}$, $m\,\frac{}{12-12}$; all the teeth close-set, except the intervals for the crowns of the long canines when the mouth is closed; canines of the shape and proportions of those in *Mustela* and *Viverra*, without trace of preparation of successors in the sockets; of quite mammalian character. Incisors longish and slender, molars subcompressed, both with simple pointed crowns, of equal length, and undivided roots. Original transmitted by Governor Sir Geo. Gray, K.C.B. From the sandstone rocks, Rhenosterberg.

Cynochampsa laniarius, the Dog-toothed Gavial (from κυων, dog, and χαμψα, Egyptian name for Crocodile, applied by Wagner to the Indian Gavial). This genus and species is founded on the rostral end of the upper and lower jaws of a Crocodilian Reptile, with a single terminal nostril, situated and shaped as in *Teleosaurus*, and indicating similarly long and slender jaws. Only the incisive and canine parts of the dentition are preserved; but these closely correspond with the same parts in *Galesaurus*, the incisors being equal and close-set, of simple conical form, and the canines suddenly contrasted by their large size. In shape they resemble closely the completely formed canines in Carnivorous Mammals. There is no trace of successional teeth. Original transmitted by Governor Sir Geo. Gray, K.C.B., from Rhenosterberg, South Africa.

Fam. DICYNODONTIA. Subgenus *Ptychognathus*, Ow. (πτυχος, ridge, γναθος, jaw.)—This subgenus is founded on four more or less entire skulls, two retaining the lower jaw, referable to two species.

Ptychognathus declivis, Ow.—Plane of occiput meeting the upper (fronto-parietal) plane at an acute angle, rising from below upward and backward, as in the feline mammals; fronto-parietal plane bounded by an anterior ridge, extending from one superorbital process to the other; from this ridge the facial part of the skull slopes downward in a straight line, slightly diverging from the parallel of the occipital plane; superoccipital ridge much produced and notched in the middle; the occipital plane, owing to the outward expansion of the mastoid plates, is the broadest part of the skull, which quickly contracts forward to the ridged beginnings of the alveoli of the canine tusks; orbits oblong, reniform, suggestive of the reptile having the power of turning the eyeball, so as to look upward and backward as well as outward. Remains of sclerotic plates. Nostrils divided by a broad, flat, upward production of premaxillary, situated nearer the orbit than the muzzle, smaller than in type *Dicynodon;* temporal fossæ broader than long, and with the outer border longest; palate with single large oval vacuity, bounded by palato-pterygoid ridges; occipital hypapophyses proportionally thicker than in *Dicynodon tigriceps;* no trace of median suture in parietal, which is perforated by a foramen parietale; frontals divided by a median suture; support a transverse pair of small tuberosities; anterior boundary-ridge of vertex formed by the nasals and prefrontals, the outer surface of both being divided into a horizontal and sloping facet; lacrymal bone extending from fore-part of orbit half an inch upon the face to the nostril; premaxillary long and single, its median facial tract flat, with a low median longitudinal ridge; maxillaries forming the lower boundary of the nostrils, and uniting above with the prefrontal lacrymal and nasal bones, their outer surface divided by the strong ridge suggesting the subgeneric name; teeth of the upper jaw restricted to the two canine tusks, the sockets of which descend much below the edentulous alveolar border; lower jaw edentulous, deep, and broad, with the fore-part of the symphysis produced and bent up to meet the seemingly truncate end of the premaxillary, a character indicating, with the angular outline of the skull, the subgeneric distinction.

Ptychognathus verticalis.—The skull of this species, repeating the subgeneric characteristics of the foregoing, has the facial contour descending almost vertically from, and at almost a right angle with, the fronto-parietal plane. Orbits proportionally larger and more fully oval. Ridged sockets of the canine tusks descending more vertically from below the orbits. Originals transmitted by Governor Sir Geo. Gray, K.C.B., from Rhenosterberg, South Africa.

Subgenus *Oudenodon*, Bain (*ουδεις*, none, *οδους*, tooth). The skull in this subgenus presents the divided nostrils, the structure and the rounded contours of that of the true *Dicynodons;* also the same form, relative size and position of the orbits and nostrils; but the zygomatic arches are more slender, straight and long; and, although there be an indication of an alveolar process of the superior maxillary, the lower part of which projects slightly beyond the rest of the edentulous border of the jaw, it does not contain any trace of a tooth, so that both jaws are edentulous, a character which had attracted the attention of their discoverer, Mr. Bain, who, in indicating it, proposed the name *Oudenodon*.

It is permissible to speculate on the possibility of these toothless Dicynodontoids being, after the analogy of the Narwhals, the females; or of their being individuals which had lost their tusks without power of replacing them, as the known structure of the true Dicynodons indicates. But there are characters of the zygomatic arches and temporal fossæ which differentiate the toothless skull sufficiently to justify their provisional reference to a distinct subgenus.

Hyoid apparatus of *Oudenodon*.—Beneath one of the skulls, and imbedded in the matrix between the mandibular rami, were the following elements of the hyoid apparatus:—basi-hyal, cerato-hyals, thyro-hyals (or hypo-branchials), cerato-branchials, and uro-hyal.

The cerato-hyals are long, subcompressed, expanded at both ends; the thyro-hyals shorter and more slender; the cerato-branchials with a sigmoid flexure; the uro-hyal symmetrical, broad, flat, semicircular, with a production like a stem from the middle of the straight anterior margin. This apparatus shows the complexity by which that in Lizards and Chelonians differs from the hyoid in Crocodiles, and ombines Chelonian with Lacertian characters. Transmitted by Mr. Bain from South Africa.

Dicynodon tigriceps.—Pelvis: Ilium, ischium, and pubis coalesced to form an os innominatum, with the suture at the symphysis obliterated. At least five sacral vertebræ, the first with a broad, thick, triangular, terminally expanded pleurapophysis. The strong, straight, trihedral ilium overlies the above sacral rib, and extends forward to overlie also the last long and slender rib of the free trunk (thoracic) vertebræ. There are no lumbar vertebræ.

Pubis very thick, strong, with a broad inferior convexity resembling that of the *Monitor* in its internal perforation and external apophysis; ischium receiving the abutment of the last two pairs of sacral vertebræ.

The form of the anterior aperture of the pelvis is oval, with the sides broken by a slight angle at the middle, and the small end encroached upon by the right angular prominence of the symphysis pubis. The long diameter is 11 inches (from the fore-end of the first sacral vertebra), the transverse diameter is 10 inches. The fore-half of this aperture is bounded by the first sacral vertebra exclusively, at the middle by its centrum, at the sides by its ribs; the hind-half of the aperture is bounded by the pubic bones. From the penultimate sacral vertebra to the symphysis pubis it measures 5 inches.

The outlet of the pelvis is of a semi-elliptic form, 9 inches in transverse, and 4 inches in the opposite diameter. Original transmitted by Mr. Bain from East Brink River, South Africa.

CROCODILIA (?). Genus *Massospondylus*, Ow. (Gr. μασσων, longer; σπονδυλος vertebra).—The author exhibited diagrams, and pointed out the characters on which he had founded (in the Catalogue of Fossil Remains of the Museum of the College of Surgeons) the genus *Massospondylus*, exemplified by the *M. carinatus*.

Genus *Pachyspondylus*, Ow. (Gr. παχυς, thick; σπονδυλυς, vertebra.)—The fossils exemplifying this genus form part of the same collection, obtained by Messrs. Orpen from sandstones of the Drabenberg range of hills, South Africa, and presented to the College of Surgeons.

2. "On the South-easterly Attenuation of the Lower Secondary Rocks of England, and the probable depth of the Coal-formation under Oxford and Northamptonshire." By Edward Hull, Esq., A.B., F.G.S.

By a series of comparative sections, made by actual admeasurements by the officers of the Geological Survey, it was shown that all the Lower Secondary formations attain their greatest development towards the north-west of England, and, on the other hand, they become attenuated, and in some cases actually die out in the opposite direction. For example, it was shown that the Bunter Sandstone in Cheshire reaches a thickness of 2,000 feet, in Staffordshire 600, and in East Warwickshire is absent; and a similar law of south-easterly attenuation was shown to maintain in the case of the Keuper, Lias, Inferior Oolite, and lower zone of the Great Oolite.

It was shown that the upper zone of the Great Oolite (the White and Grey Limestones of Wilts, Oxford, Lincoln, and Yorkshire,) forms the first exception to the law; and from the fact of its occurrence in the Bas-Boulonnais below the Chalk, and resting on Carboniferous rocks, the author inferred that it extends more or less uninterruptedly from England to France and Belgium, and southward to Mr. Godwin-Austen's palæozoic axis. The cause of this superior degree of persistency was referred to the organic, as distinct from the sedimentary nature of the formation, and its accumulation (like the White Chalk) on a deep sea-bed by the agency of Molluscs, Corals, and Foraminifera.

It was shown that the Lower Permian beds are scarcely represented in Lancashire and North Cheshire, but that they attain their greatest development (1,800 feet) along a band of country stretching west and east from Salop to Warwickshire, and the author traced the margin of the basin in which they were formed along the west, north, and east. The *local* origin of these Permian beds, as having been derived from the Old Red and Silurian lands by which they were surrounded, was insisted upon, and especially as agreeing with the observations of Murchison, Ramsay, and other authors.

As contrasted with this local origin of the Lower Permian rocks of Central England, it was shown that the sedimentary materials of which the Triassic Rocks are formed must have been drifted by an ancient oceanic current from a continent or large tract of land occupying the position of the North Atlantic, and that the sediment was spread over the plains of England as long as it was mechanically suspended. The increasing distance towards the south-east from the source of supply, accounted for the tailing out of the sediment. During the Bunter Sandstone period, this sediment was drifted through the channel formed by the great headlands of Westmoreland and North Wales; but, as the whole area was gradually sinking (with occasional interruptions) during the periods of the Upper Trias and succeeding formations, the Welsh and Cumbrian mountains must have been nearly covered by sea at the close of the Liassic period.

The author adduced the following reasons for considering that the Bunter Sandstone of England formed dry land during the deposition of the Muschelkalk of Germany.

1st. That the Lower Keuper Sandstone rests on an eroded surface of the Bunter; 2d, that the basement-bed of the Keuper is frequently a breccia or shingle-beach; and 3d, that there is a local unconformity observable in Stafford, Leicester, and Lancashire, between these formations.

The author described the distribution of the quartzose conglomerates which form the middle division of the Bunter, and considers it probable that they are the reconstructed materials of the Old Red Conglomerate of Scotland.

The probable extension of coal-measures from the coal-fields of England to those of Belgium and France was considered, as also the bearing of the whole subject on Mr. Godwin-Austen's theory of the extension of coal-measures under the chalk of the Thames Valley; and it was inferred that coal-measures might possibly be found at not unapproachable depths under parts of Oxford and Northamptonshire. It was also shown, that, from indications presented by the coal-formation at the southern borders of the Staffordshire and Warwickshire coal-field, there was reason to suspect that the formation becomes attenuated and less productive of valuable coal-beds in its extension towards the south-eastern districts.

The paper was illustrated by a series of comparative horizontal sections across the midland counties.

GEOLOGISTS' ASSOCIATION.—*April* 4.—The fourth ordinary meeting was held at the Society's Rooms, 5, Cavendish Square, Dr. Hyde Clarke, V.P., in the chair. A very interesting paper was read by the Rev. T. Wiltshire, M.A., F.G.S., President of the Association, on "The Red Chalk of England." It was stated that the red chalk occurs *in situ* only in the counties of Yorkshire, Lincolnshire, and Norfolk. It is first seen at Speeton, about six miles from Flamborough Head, in Yorkshire, where it rests unconformably upon the Speeton clay and underlies the white chalk. It is there about 30 feet, which appears to be the greatest thickness it attains, and is traceable from Speeton in a westerly direction for about 20 miles, when, turning at a sharp angle, it proceeds across Yorkshire towards the south-east, and disappears below the marsh-land, about seven miles to the west of Hull. It re-appears at Ferraby, in Lincolnshire, and there may be traced across Lincolnshire until it is cut off by the Wash, on the south shore of which,—at Hunstanton, in Norfolk,—it is again found, and may be traced from that place to a few miles north of Lynn, after which it is seen no more. In Lincolnshire and Norfolk it underlies the white chalk, and rests upon a dark pebbly mass which is supposed to belong to the lower greensand. At Hunstanton it is only 4 feet in thickness, and assumes a different character from that which it presents at Speeton, being much harder, darker in colour, and containing pebbles, which are not seen in the red chalk of the latter place. The red chalk appears to be very fossiliferous, containing serpulæ, terebratulæ, corals, sponges, belemnites, &c.; and from the circumstance of some of the belemnites being of species characteristic of the gault, the author considered the red chalk as the equivalent of that formation. Fragments more or less rolled had been found in the drift at Muswell Hill; from which it was inferred that the red chalk must have at one time existed in large masses over a considerable tract of country. These fragments appeared to be, in mineral character, and by the fossils contained in them, identical with the red chalk of Hunstanton. The paper was illustrated by some admirable diagrams, and by specimens from the cabinets of Dr. Bowerbank, N. T. Wetherell, Esq., and the author.

NOTES AND QUERIES.

Thickness of Chalk-strata around the Wealden Area.—The Editor will be obliged by notes on the local thickness of the Chalk and Lower Greensand in Surrey, Kent, Sussex, and the contiguous counties; as obtained by well-sinkings and other sources.

Geological Topography.—"Sir,—Would it be worth the trouble to publish a list of the towns of England, with their strata?—I send a specimen of what I mean, as you will understand it better from that.—Yours, &c. G. H. West, Blackheath."

Name.	*Latitude.*	*Longitude.*	*Strata.*
Abbots Bromley.	52 deg. 49 min. N.	1 deg. 45 min. W.	New red sandstone.

Character.	*Fossils.*	*For what used.*	*Avge. Depth.*	*Division.*
Clays, coloured sandstones, and conglomerates.	Few discovered, foot-prints.	Architectural purposes.	900 ft.	Mesozoic or Secondary.

We think in a modified form such a list might prove very useful, especially one of the chief towns with their prominent geological features, of those noted for the occurrence of particular fossils, and of those where good sections of particular rocks are to be seen. If our readers and correspondents will supply the information, we will revise, arrange, and print the matter thus accumulated.—Ed. Geol.

Shells in Pleistocene Deposit at Cambridge.—"Sir,—Would you inform me, through the medium of your valuable 'Notes and Queries,' if it be usual for the drift to contain shells of such fragile forms as those which I have inclosed for your inspection; and also whether these are freshwater or marine? Also, could you tell me of any work of moderate price devoted exclusively to the drift formation? The shells forwarded were found in the drift, about 10 or 12 feet below the surface, in a thin layer of fine sand about 4 inches thick, resting upon a sort of clayey sand about 18 inches thick, which last also contained shells, but not in such abundance as the other.—Yours, &c. A Beginner, Cambridge."—The deposit in which the shells forwarded were found, we should consider to be a Pleistocene freshwater deposit, and not drift. The species we recognise are:—

Helix nemoralis,
—— arbustorum,
Lymnæus pereger,
Valvata piscinalis,
Bythinia tentaculata,
Cyclas cornea,
Pisidium obliquum,
Clausilia,
Unio, &c.

Land and freshwater shells are by no means unusually found in such deposits, which should be searched also for mammalian remains, the newer forms of which may occur, though not the hippopotamus and older species.

Cement for Chalk Fossils.—"Dear Sir,—Can you kindly give me the receipt for making the 'diamond cement' used in repairing chalk fossils?—Yours faithfully, J. R. C."—"SIR,—I have collected fossils for the last two years, more especially those from the chalk, but I find it extremely difficult to prevent teeth, &c. from breaking off. I have used thick gum-water for sticking the specimens together, but I find it very unsatisfactory, in consequence of gum being acted upon by the weather. 1st. Can you recommend me any good cement of which chalk will not absorb all the moisture, and which will not show a black mark where the specimens are joined? 2nd. Have geologists ever found any fossil pearls among the oyster and other beds of fossil shells?—Yours, &c. ENQUIRER."—1st. All chalk specimens should be saturated in a weak solution of gum, size, or other similar material, before the joining of the fragments is attempted. Ackerman's cement, procurable at those well-known artist's colourmen's establishment in the Strand, is a very useful preparation for repairing chalk and other fossils. 2nd. Fossil pearls have been, although rarely, found. Specimens from the large Inocerami of the chalk have been long known. One very large and beautiful specimen is in the collection of N. T. Wetherell, Esq. of Highgate, and has been described in the "Annals of Natural History."

ORIGINAL THICKNESS OF THE PURBECK DIRT-BED.—"SIR,—In the volume of THE GEOLOGIST for 1858, is an article on 'Voices from the Rocks,' (p. 543). It is admitted by the author of that book, that the dirt-bed in the Isle of Portland, from whence so many fossil trees have from time to time been extracted, is from 12 to 18 inches in thickness.

"I had the pleasure of visiting that interesting dirt-bed a few years ago, and it struck me at the time that the bed of mould was originally very much thicker when it formed part of the surface, and when the trees were growing upon it, and before the bed of hard and compact limestone, 9 feet 7 inches thick, was deposited over it.

"The enormous pressure of such a mass of stone upon such a bed of vegetable soil as the dirt-bed then was, must have greatly reduced its thickness.

"We ought also to consider the effect which long periods of time would have on such soil, from the escape of the various gases which compose the humus always present in larger or smaller quantity in all soils.

"With regard to trees thriving on a thin soil, I beg to observe that about seven or eight years ago, at a slate-quarry at Swithland, near Leicester, I saw a thrifty young oak having a trunk 2 feet in diameter, growing upon a large accumulation of fragments of slate, the refuse of the quarry, and thriving apparently without any soil except that formed of the fragments of slate.

"This oak I thought was also a good memorial of the ancient date of the former working of the slate-quarry.—JOHN BROWN, F.G.S., Stanway."

SHOAL OF FISH BURIED IN SAND.—The following extract is from a paper entitled "A Week in Gaspe," by Dr. Dawson, in the Canadian Naturalist, for October last:—

"On the long sand-point that, stretching far into the bay, shelters the harbour along which we walked in search of whales' bones and shells, I observed an appearance new to me, and of some geological interest. Shoals of the American 'Sand-Launce' (*Ammodytes Americanus*), a little fish three or four inches in length, had entered the bay, and either seeking a place for spawning or for sheltering themselves from their numerous enemies, had run into the shallow water near the point, and, according to their usual habit, had in part buried themselves in the sand, which they throw up by means of their long pectoral fins. In this situation countless multitudes had died or been thrown on shore by the surf, and the crows were fattening on them, and the fishermen collecting them in barrels for bait: acres of them still remaining, whitening the bottom of the shallow water with their bodies. It was impossible not to be reminded by such a spectacle of the beds full of capelin in the post-pliocene clay of the Ottawa, and the similar beds filled with fossil fishes in other beds as far back as the Old Red Sandstone. Geologists have often sought to account for such phenomena, by supposing sudden changes of level or irruptions of poisonous matter into the water; but such catastrophes are evidently by no means necessary to produce the effect. Here, in the quiet water of Gaspe Bay, year by year, immense quantities of the remains the 'sand-launce' may be embedded in the sand and mud without even a storm destroy them. Similar accidents, I was told, happen to the shoals of capelin; that there is nothing to prevent the accumulation here of beds equally rich in he remains of fishes with those other deposits of ichthyolites that have excited much interest and wonder."

Mastodon Remains in Canada.—Some fossil remains of a monster animal, upposed to be those of a mastodon, have lately been discovered in the county of lgin, C.W. The St. Thomas *Despatch* describes them as follows:—"We were hown on Tuesday last, by Mr. Freeborn Berdan, the gigantic tooth of a monster nimal, which was found on the farm of Mr. Samuel Berdan, two miles west of ive Stakes, some time last week, while digging in a light sandy loam on the edge f a small marshy spot, about twenty inches below the surface. The tooth shown us was about seven or eight inches in length across the face, by four or five in width, and seemed to have been broken out of the jaw. The surface was perfectly smooth, and appeared to us as if it had been petrified or very heavily enamelled. It was of a mottled grey colour at the upper part, running down to a dark brown at the base. The interior was similar to a white calcined bone. Mr. Berdan also found two enormous tusks, eight and a half feet from one end to the other, and curving back so that the two ends are nearly parallel to each other; also two thigh-bones, three feet long, an under jaw-bone over three feet long, several ribs from three to four feet in length from point to point, and six teeth, weighing six pounds or more each. These bones, as near as can be ascertained, are supposed to belong to a mastodon, an extinct species of the elephant, and have probably remained undisturbed where they were found for centuries before the continent was discovered. Some parts of them were in a high state of preservation, while others would crumble to pieces by the slightest touch, and their places have been filled by a substitute."

Geological Excursions.—During the past month a series of practical field-lessons on Geology have been given by Professor Morris to the students attending the Geological Class at University College, London; the chief attention in these excursions being directed to the method of describing sections of the strata, the tracing their boundaries, and mapping their extent; to the mode of occurrence of fossils in the different layers, whether entire or broken, as indicating the condition under which they were deposited, and the natural history and characters of the animals, as evidencing the medium (*i.e.* marine or freshwater) in which they lived and died.

The environs of London present many localities for studies of this nature. One excursion included the Woolwich and Charlton pits, where the fluvio-marine series of the Lower Tertiaries are well exhibited; and their infraposition to the marine bed of London clay was shown by a traverse made to Plumstead Common, where the superposition of the lower beds of the London Clay is exposed. The mammalian deposits of the Wickham Valley were also visited. Another excursion included the examination of the freshwater and mammalian deposits of Crayford and Erith, which show how these fluviatile accumulations of brick-earth were deposited upon an eroded surface of the Lower Tertiaries (Thanet sands) and the chalk; the rich mammalian and molluscan fauna obtained from these pits being examined in the collection of Mr. F. Spurrell, of Bexley, who kindly offered every facility for the inspection. A third excursion embraced the more interesting geological features of the Isle of Wight, as exhibited in the fine sections of the Tertiary strata at White Cliff, and Alum, and Colwell Bays, and in the interesting section of the Wealden and Cretaceous series as exposed in the traverse made along the south part of the island, from Sandown to Compton Bay.

Dendritic Markings; Movements of Pentacrinite Plates in Vinegar.—"Dear Sir,—If you, or some of your numerous correspondents in the 'Notes and Queries' department of your most excellent Magazine, will have the kindness to answer the following questions, I shall feel much obliged.

"1. What is the cause of the Dendritic appearances on Chalk?

"I have some fossils from a quarry at Benereuagh (County Derry), which are beautifully marked, especially the Echini. This appearance is not confined to the fossils only; the chalk itself is of a creamy colour, and the drawings on it look as if done with Indian ink by a very fine pencil. I have observed the same description of markings on the chalk and fossils of the White Rocks, near Dunluce Castle, County Antrim.

"I send you a small quantity of the dendritic grains, and a little bit of chalk. The drawing upon it is not so distinct as I could wish; in some chalk it is perfectly black, and very beautiful indeed, and in all such instances I observe that the chalk is of peculiar hardness, while at the same time the markings penetrate deeper, with increased depth of colour as they proceed; but in the softer chalk the tintings are brownish, and more on the surface.

"Are those moss-like figures common to all chalk?

"2. Why do those portions of Pentacrinites, commonly called 'star-stones,' move with a sensible rotatory motion in a vessel of vinegar; or why do they move at all? And why will not a portion of Belemnite, or plain limestone, both from the same rock, and of the same size as the 'star-stone,' move also?—Very truly yours, A. DE S. M., Port Stewart."

1st. The beautiful feathery dendritic markings in chalk and on chalk fossils are due to a crystallization of manganese either on the planes of cracks and fissures, in the fine interstices between the rock-matrix and the fossils, or filling up minute cracks in the structure of the rock itself. Such dendritic markings are found in most solid rocks, and have been very commonly attributed to iron. We believe, however, that when iron puts on the dendritic form it is due to the admixture with it of manganese. Where the proportion of iron is larger, the dendritic markings are dingy and obscure, and by a few days' exposure to the air diminish to a brown stain. Where the manganese predominates, the dendritic ornamentation is sharp, clear, and defined, and of a dense black colour.

We have analysed the sample forwarded, and find that it contains the larger proportion of manganese with traces of iron.

The quantity sent was quite sufficient for a qualitative, but not for a quantitative, analysis; so that we cannot state the exact proportion of the two ingredients. These dendritic markings therefore are due to manganese.

Very pretty dendritic sculpturings are to be made artificially, by mixing clay with a solution of sulphate of copper, and baking or otherwise quickly drying the mass.

2d. The "Star-stones" move on account of the evolution (by the action of the vinegar upon the carbonate of lime of which the pentacrinite plates are composed) of small globules of carbonic acid gas. Sometimes these may be seen clustered round the "star-stone," but often they are so minute, from the very slow action of the vinegar, as to be scarcely visible with a pocket-lens.

Why bits of limestone or belemnites do not likewise move, may be thus explained:—

The star-stones are of very hard and compact structure, and the gas therefore is very slowly evolved by the weak action of the vinegar. From this cause the minute bubbles congregate under the star-stone, where they are, by the hollows and sculpturings of which they are retained, and the star-stone, rendered slightly buoyant. Then as the bubbles burst into each other, and become confluent, or as they tilt up first one edge then another of the star-stone in escaping, a slight mechanical action is set up sufficient to cause the rotatory motion alluded to by our correspondent. In the case of common belemnites, limestone, &c., the carbonate of lime being softer, the gas is generated more quickly and in larger bubbles, and consequently readily escapes without at all serving to float, by clinging to it, the object from which it emanates.

"DEAR SIR,—I am frequently applied to by stranger geologists, respecting information on the Ledbury and Malvern districts. You would, I think, be rendering ramblers a service by informing them that they will find Henry Brooks, shoemaker, the Homend, Ledbury, a most intelligent and efficient guide. He has lately discovered there '*Auchenaspis Salterrii*,' one of the rarest of the Tilestone fossils.—Yours very truly, W. S. SYMONDS, Pendock Rectory, Ledbury."

THE GREAT ICHTHYOSAURUS PLATYODON (?) AT THE YORK MUSEUM.—"SIR,—I was glad to see your correspondent, Mr. S. R. Pattison, bringing forward the subject of Provincial Museums in the pages of THE GEOLOGIST. I should have sent you a communication on this subject six months ago had I not entertained the idea of publishing, as a separate pamphlet, some observations upon the Condition of Natural History Museums throughout the kingdom, with suggestions for putting some of them in a more efficient state. I have lately visited the Museums of Newcastle, West Hartlepool, Whitby, Scarborough, Hull, Leeds, Kendal, Lancaster, Preston, Warrington, Manchester, and Ipswich, and in the course of a few days I purpose visiting those of Bristol, Bath, Liverpool, &c. I have only time now to call the attention of your readers to the noble room which has just been added to the Museum at York, and for the erection of which nearly a thousand pounds has been subscribed. Some time since an enormous Ichthyosaurus was discovered in the neighbourhood of Whitby, and, after a good deal of negotiation with the persons into whose hands this extraordinary Saurian remain had fallen, I became the possessor of it for the sum of one hundred and ten pounds. My object in making the purchase was the hope that, when brought to York, the members of the Yorkshire Philosophical Society would raise by subscription the above sum, to take the specimen off my hands and place it in the Museum. We had just started a subscription when the Rev. D. R. Roundell, of Gledston, Skipton, sent me a cheque for the whole amount, that he alone might have the satisfaction of presenting so grand a fossil to the York Museum. It was this acquisition that led to the building of the new room. If you have space for its insertion you shall have some more Provincial Museum information for your June number.—EDWARD CHARLESWORTH (of York)."

MAMMALIAN REMAINS.—"In the 'Gentleman's Magazine' for 1757 several extracts from letters communicated by Mr. Collinson, concerning mammalian remains, are printed, of which I append a summary:—

"'At Barton, in Sussex, in July, 1740, some bones of elephants were found. These remains were nine feet deep in the ground, and were discovered by some men digging a trench in the park. The remains found consisted of various bones, "a large tooth (tusk), seven feet six inches in length, which, as it lay on the ground, was entire, but on taking it up, broke all to pieces." After this several more were found in carrying on the trench, particularly the fellow to the before-mentioned ivory tooth, exactly of the same length, which being taken up with more care, is now to be seen, though both ends were broken off. Also two more shorter tusks, of about three feet in length; a thigh-bone, forty inches long, and thirty-one inches in the thickest part. There were several other bones, as the knee-pan; but the most perfect of all was one of the grinders, not in the least decayed, with part of the jaw-bone, which together weighed above fourteen pounds; the upper part of the tooth, where it meets its opposite, was six inches and a half long and three inches broad. There were several other bones not here mentioned.

"'But what is very remarkable is that these teeth, bones, &c. did not lie close together, as one might suppose those of a skeleton to do, but at some distance asunder; and the larger tusks were full twenty feet apart.

"'The Rev. Dr. Longwith, minister of Petworth, has most of them, excepting one of the largest tusks and one large bone. He was here at the taking of them up, and reasonably concludes they were not thrown in by hand, but buried in the universal deluge.

"'P.S. In the past hard winter there was killed a swan at Emsworth, between Chichester and Portsmouth, lying on a creek of the sea, which had a ring round its neck, with the King of Denmark's arms on it.'

"The following are from Letter II. by Mannock Strickland, Esq., April 4, 1741:—'A few months after the foregoing letter was written, being near Mr. Biddulph's, I paid him a visit, when I saw the greatest part of one of the great teeth; it was seven feet and a half long; and at Dr. Longwith's I saw the other, with the rest of the bones mentioned in Mr. Biddulph's letter, all things agreeing exactly with his descriptions. I saw also the pit it was digged out of, and observed the various strata which run parallel and had never been disturbed.

"'Within a quarter of a mile south runs a vast mountainous ridge of hills, called the South Downs of Burton Hills, from the name of the parish Mr. Biddulph lives in.'

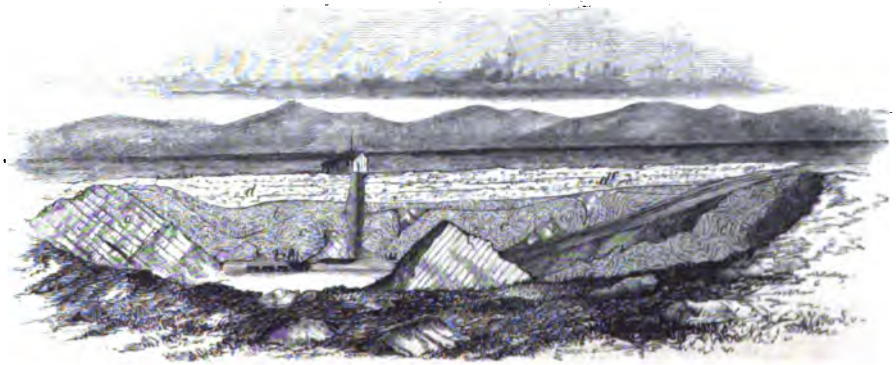
"Extracts from Letter III. by a Rev. Clergyman to Peter Collinson, Esq., F.R.S. Bristol, October 23, 1756:—'I had also forgot to tell you of a noble acquisition since my tour to Wales. A gentleman who was digging, upon a hill near Mendip, for ochre and ore, found at the depth of 52 fathoms, or 315½ feet (as he measured himself by direct line), four teeth, not tusks, of a large elephant (which I think is the whole number the creature has), and two thigh-bones, with part of the head; all extremely well preserved; for they lay in a bed of ochre, which I could easily wash off. When they were brought to me, every crevice was filled with the ochre, and as I washed it off from the outside, a most beautiful white surface appeared; and they make a fine show in my cabinet. I propose going down into the pit myself soon; for the men have left several small pieces behind, which they did not think worth bringing up, and I make no doubt, if that be the case, but I shall procure the whole, or great part of the animal. I have also, since I saw you, got part of an immensely large stag-horn, undoubtedly fossil, dug up ten miles from Bristol.'

"OBSERVATIONS BY PETER COLLINSON, ESQ.—'In England the teeth and bones of elephants have been often found fossil; and yet it is allowed on all hands that so many elephants were never brought hither by men, as have been dug up. In particular, besides the above accounts, I had a large grinder from Norfolk, which was found with other teeth and bones. From Mersey Island, in Essex, were sent me a large grinder and part of a thigh-bone; these were found with the entire skeleton, which was destroyed by the country people. Mr. John Luffkin, in the "Philosophical Transactions," No. 274, mentions bones and teeth of an elephant found near Harwich, in Essex. Mr. Somner, in No. 272, mentions an elephant found at Chartham, near Canterbury; the teeth were all grinders, four in number. Dr. Woodward mentions two large tusks of an elephant, found at Bowden Parva, in Northamptonshire. He had besides several pieces of elephants' teeth, dug up in a gravel-pit at Islington. Unless we allow Dr. Woodward's hypothesis of the deluge, it is difficult to conceive how the teeth, bones, &c. of this vast animal come to be found so frequently in this island. The Romans were the only people who could bring any to intimidate the Britons in their wars; but we have not the least account of any such thing.'

"KETTERING, NORTHAMPTONSHIRE.—'Here we discovered a tooth, vertebra, and jaw-bone of some animal of an enormous size, and of a species different from any creature that is now bred and supported in our climate; these, with the thigh-bone of a beast of more moderate size, were found in the aforesaid gravel-pit, at the depth of about seven feet, in places which had never before been opened, &c.' —Gent. Mag. 1757, p. 21.

"The following I met with in the 'History of the County Palatine of Durham,' Mackenzie and Ross. At Maineforth, a hamlet three miles N.W. of Sedgefield, 'about the year 1740, the horns of a moose-deer were dug out of a pond here, one of which is preserved, measuring from root to tip three feet eight inches, and ten inches in circumference above the root; the greatest breadth fourteen inches. Several of the branches are evidently broken off.'—I am, dear Sir, Yours truly, F.S.A."

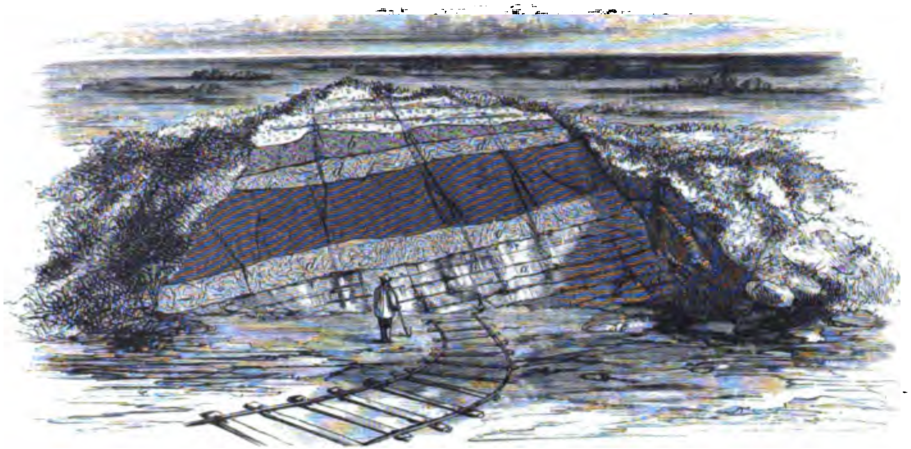
CLINOMETERS.—OBSERVER asks what is the best form of Clinometer, and where such instruments are to be obtained?—A useful form of Clinometer is a little square box-compass, having a pendulum attached to the axis, so that when the box is opened and set on edge, the pendulum swings against the graduated card. A little spirit-level can easily be fixed in one edge of the box; and brass sights can be also added. Such an apparatus is prepared by Knight, Foster Lane; and probably can be procured also at Fenn's and Buck's, Newgate Street, and Marryatt's, King William Street.



MWYNDY IRON-MINE, near LLANTRISSANT

a Carboniferous Limestone
b Conglomerate
c Bed of Hæmatite
d Superficial Drift

S. J. Mackie del



SECTION of HÆMATITE and MANGANESE MINE, GUAR COCH, near BRIDGEND

S. J. Mackie del

THE GEOLOGIST.

JUNE, 1859.

ON ROCKS; THEIR CHEMICAL AND MINERAL COMPOSITION, AND PHYSICAL CHARACTERISTICS.

By H. C. SALMON, ESQ. Plymouth.

(*Continued from page 59.*)

XXI. **RELATION BETWEEN THE PHYSICAL CHARACTERS OF A MINERAL AND ITS CHEMICAL COMPOSITION.**—In the definition which I have given, a mineral is described as a body possessed of a definite chemical composition and a regular physical form,—meaning by the latter particularly crystalline structure. But, while the crystalline relations of each species only vary within the narrowest limits, the chemical composition has a much wider latitude. Many individuals of the same mineral species are found, by analysis, to differ most widely in their chemical components, while the crystalline form is quite unaltered. Now, although we are as yet unable to trace the relation between the form of a mineral and its composition, there can still be little doubt that some such relation does exist, regulated by laws yet to be discovered; consequently, when we find the same mineral species differing widely in chemical proportions, we recognise a departure from regular although unknown laws, and seek for a cause. This we find in the doctrine of *Isomorphism*. This, simply stated, is the capability of two or more substances, of analogous chemical constitution, to crystallize in similar forms. Thus, as a few examples in the mineral kingdom, we find that *Corundum* ($\dddot{\mathrm{A}}\mathrm{l}$) and

Hematite ($\overset{\cdots}{\mathrm{\bar{F}e}}$) crystallize in nearly identical forms: the same is the case with *Rock-salt* ($\mathrm{Na\ Cl}$) and *Fluor* ($\mathrm{Ca\ Fl}$): and the Carbonates of Lime, *Calcite* ($\overset{\cdot}{\mathrm{Ca}}\ \ddot{\mathrm{C}}$), of Magnesia, *Magnesite* ($\overset{\cdot}{\mathrm{Mg}}\ \ddot{\mathrm{C}}$), and of Protoxide of Iron, *Chalabite* ($\overset{\cdot}{\mathrm{Fe}}\ \ddot{\mathrm{C}}$), have also similar crystalline relations. What is the case with these, and numerous other minerals occurring naturally, also holds good with many other bodies, which are only produced artificially in the laboratory.

As isomorphous bodies are found to have the same form when they crystallize in an uncombined state, so it is likewise found, when they enter into combination as the components of substances of a more complicated chemical nature, that the isomorphic property is still continued, and that they are capable of mutually replacing each other without causing any essential change in the crystalline relations of the compound substance. For example, $\overset{\cdots}{\mathrm{\bar{A}l}}$ and $\overset{\cdots}{\mathrm{\bar{F}e}}$ are isomorphous, as are likewise $\overset{\cdot}{\mathrm{Ca}}$ and $\overset{\cdot}{\mathrm{Fe}}$. In the mineral *Garnet*, one variety is thus composed: $\overset{\cdots}{\mathrm{Si}}$ 40 per cent., $\overset{\cdots}{\mathrm{\bar{A}l}}$ 25 per cent., and $\overset{\cdot}{\mathrm{Fe}}$ 33 per cent. In another variety the $\overset{\cdots}{\mathrm{\bar{A}l}}$ and $\overset{\cdot}{\mathrm{Fe}}$ are wholly replaced by their respective isomorphs $\overset{\cdots}{\mathrm{\bar{F}e}}$ and $\overset{\cdot}{\mathrm{Ca}}$, the composition of the mineral being $\overset{\cdots}{\mathrm{Si}}$ 40 per cent., $\overset{\cdots}{\mathrm{\bar{F}e}}$ 29 per cent., and $\overset{\cdot}{\mathrm{Ca}}$ 30 per cent.: and all this substitution without any change of crystalline form.

Although isomorphic replacements do not alter the essential form of a mineral (which is its crystalline form), they often give rise to considerable changes in its other physical characters. This is peculiarly the case when the oxides of the heavy metals replace the earths and alkalies, giving rise to changes particularly in colour and specific gravity. The many varieties which characterise some mineral species are generally due to this. See the cases of Epidote, Garnet, Augite, Hornblende, &c.

Among the large number of isomorphous bodies enumerated by mineralogists and chemists, those that concern us in rock-minerals are comparatively few. Those most worthy of attention are :—

Elements . . . . Fl, Cl.

Compounds of 1 atom of base united with 1 atom of oxygen . . . . { *a.*—$\overset{\cdot}{\mathrm{Ca}}$, $\overset{\cdot}{\mathrm{Mg}}$, $\overset{\cdot}{\mathrm{Fe}}$, $\overset{\cdot}{\mathrm{Mn}}$, $\overset{\cdot}{\mathrm{K}}$, $\overset{\cdot}{\mathrm{Na}}$, $\overset{\cdot}{\mathrm{Li}}$.
b.—$\overset{\cdot}{\mathrm{Ca}}$ (as *Arragonite*), $\overset{\cdot}{\mathrm{Ba}}$.

Compounds of 1 atom of base united with 3 atoms of oxygen . . . . } $\overset{\cdots}{\mathrm{\bar{A}l}}$, $\overset{\cdots}{\mathrm{\bar{F}e}}$, $\overset{\cdots}{\mathrm{\bar{M}n}}$.

While in many minerals these isomorphs replace each other to a large extent, the student must guard against supposing they can do so *ad infinitum*, or in all instances. The example which I have given of garnet is an extreme case. In the majority of minerals isomorphism can only take place within narrow limits, and is confined to certain constituents: any increased alteration carrying with it a change of crystalline relations. No definite laws can be laid down, each group of minerals being characterised by particular powers of substitution.

XXII. *Pseudomorphism* is another incident of crystallization important in its bearing on the study of rocks. A pseudomorphic crystal is one with a form foreign to the substance which composes it. For instance, we find *Quartz* in crystals which differ entirely from its proper form, and which on examination we discover to be characteristic of various other minerals, among them *Fluor*, *Gypsum*, *Calcite*, *Pyrite*, &c. These forms are not true crystals, and the quartz has acquired them in a way entirely different from crystallization. The number of pseudomorphs already known is considerable, and will probably be yet increased. They seem principally, if not entirely, to have been brought about by slow aqueous agency gradually removing the original mineral, or some normal constituent, and substituting in its place either an entirely different body, or such a constituent as to alter essentially its original chemical character; the whole operation occurring so slowly as not to admit of the substituted or altered substance taking its proper crystalline form, thus retaining the *form* of a substance passed away. Petrifaction is a familiar instance of pseudomorphic change; there the original animal or vegetable substance is removed, and entirely replaced by a foreign mineral substance, although the original *form* in all its details is little altered.

Blum[*] classifies pseudomorphs as—

1. Alteration-pseudomorphs; produced by
    - *a.* Removal of constituents.
    - *b.* Addition of constituents.
    - *c.* Exchange of constituents.

---

[*] J. R. Blum,—Die Pseudomorphosen des Mineralreichs, mit Nachtrag. Stuttgardt, 1843-7. A very complete list of pseudomorphs, from Blum, is given in Brooke and Miller's edition of "Phillips' Mineralogy."

2. Displacement-pseudomorphs; produced by
   - *a.* Incrustation.
   - *b.* Replacement.

Magnesite ($\dot{Mg}\,\ddot{C}$) in the form of *Calcite* ($\dot{Ca}\,\ddot{C}$) is an example of an alteration-pseudomorph by exchange. The Ca of the Calcite is gradually removed and replaced by $\dot{Mg}$; thus converting the substance of the crystal into Magnesite, while it still retains the form of Calcite. The example given of *quartz* in the form of *fluor*, *gypsum*, &c., are instances of displacement-pseudomorphs, the entire substance of these minerals being removed and replaced by the quartz.

The great importance of pseudomorphs consists in this: that they furnish us with a record of changes which have taken place in the rock-world, of which without their help we should have remained entirely ignorant. If in a certain district we meet with a great series of veins filled with quartz, a considerable quantity of this quartz having the form of calcite, we have at once revealed to us the important fact that the veins were once filled with carbonate of lime, which had been removed and replaced by quartz. If the removal and substitution had taken place under circumstances favourable to the development of the quartz in its own proper form, we should have found no pseudomorphs, and have remained entirely ignorant of the change that had taken place. And this is probably more frequently the case in nature,—the form alters with the alteration of the substance; but when this is not so, and the form remains while the substance is altered, that pseudomorphous form becomes an important geological monument.

XXIII. GENERAL CHEMICAL RELATIONS OF MINERAL SALTS. — When two binary compounds unite together to form a higher one, chemists call the electro-positive of the uniting compounds the *base*, and the electro-negative the *acid*. The higher compound made by the union of this base and acid is called a *salt*.

The four earths, three alcalies, and four oxides given in the list in XIII. are the only bases, and the four acids given in the same list are the only acids, which at present concern our subject. The acids combine with the bases to form the (1) *Silicates*, (2) *Carbonates*, (3) *Sulphates*, and (4) *Borate* described; the comparative importance of which in rock-forming minerals is there explained.

These bases are classed, according to the relative amount of oxygen they contain, into *monoxide* bases ($\dot{\mathrm{Ca}}$, $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Ba}}$, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$, $\dot{\mathrm{Li}}$, $\dot{\mathrm{Fe}}$, and $\dot{\mathrm{Mn}}$) symbolized by the general formula $\dot{\mathrm{R}}$; and *sesqui-oxide* bases ($\ddot{\mathrm{Al}}$, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$, and $\ddot{\bar{\mathrm{M}}}\mathrm{n}$) symbolized by the general forbula $\ddot{\bar{\mathrm{R}}}$.*

The terms acid and base are only relative. One substance may be electro-positive with regard to a second, but electro-negative with regard to a third: in the first case it is a base, in the second an acid. In rock-minerals $\ddot{\mathrm{Al}}$ is usually a base, with respect to the acid $\dddot{\mathrm{Si}}$, but in *Spinelle* ($\ddot{\mathrm{Al}}$ $\dot{\mathrm{Mg}}$) it acts as an acid, with regard to the base $\dot{\mathrm{Mg}}$; and in many of the compound silicates, the variety of which in composition cannot be accounted for by the doctrine of isomorphism, $\ddot{\mathrm{Al}}$ is supposed similarly to act as an acid.

If one equivalent of a base always combined with one equivalent of an acid to form salts, the chemical relations of these latter would be simple enough. But this is not so: the acids and bases combine in very variable proportions, particularly in the silicates. The salt resulting from the union of one equivalent of base and one of acid is termed a *neutral* salt; those in which the base preponderates, *basic* salts; and those in which the acid, *acid* salts.†

As the only salts connected with rock-minerals which present any complication are silica-salts, I shall now proceed with the subject under that head.

XXIV. *Chemical relations of Silicates.*—I have already mentioned in XIX. the bases which unite with Silica to compose rock-forming Silicates. They are three sesqui-oxide bases $\ddot{\bar{\mathrm{R}}}$ ($\ddot{\mathrm{Al}}$, $\ddot{\bar{\mathrm{F}}}\mathrm{e}$, and $\ddot{\bar{\mathrm{M}}}\mathrm{n}$.), isomorphous with each other, and seven monoxide bases, $\dot{\mathrm{R}}$ ($\dot{\mathrm{Ca}}$, $\dot{\mathrm{Mg}}$, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$, $\dot{\mathrm{Li}}$, $\dot{\mathrm{Fe}}$, and $\dot{\mathrm{Mn}}$), isomorphous with each other.

---

* When the monoxide happens to be a protoxide, the base may also be called a *protoxide* base; and similarly when the sesqui-oxide is a peroxide, that base may be called a *peroxide* base.

† Salts are often named from their bases. Thus salts of monoxides or protoxides are called monoxide and protoxide salts; and salts of sesqui- or per-oxides, sesqui-oxide or peroxide salts. Some have also been named *haloid* salts, and consist of (1st) certain alcalies and earths united with the soluble acids (carbonic, sulphuric, and boracic); and of (2d) chlorine and fluorine with their metals (that is, the metals of the alcalies and earths). Of the 1st are—*Calcite*, *magnesite*, *dolomite*, *anhydrite*, *gypsum*, *baryte* and *boracite*; of the 2d—*Rock-salt* and *fluor*. This grouping is useful in considering the rocks made up of these minerals, which form a natural family.

The combination of one equivalent of one of these monoxide bases with one equivalent of the acid (R Si) forms a neutral Silicate. If the Silica preponderates and the salt is an *acid* salt, then, when the $\ddot{\mathrm{Si}}$ is to the base as 2 : 1, it is called a bisilicate; when 3 : 1 a trisilicate, and so on. Conversely, when the base preponderates and the salt is *basic*, then, when the base is to the $\ddot{\mathrm{Si}}$ as 2 : 1, it is called a bibasic silicate, when 3 : 1 a tribasic silicate, and so on. This nomenclature is only applicable to the monoxide salts; but it is also applied to the sesqui-oxide salts in the manner explained below.

It is found, however, that the chemical relations of silica-salts are not so adequately or simply expressed by a statement of the proportionate combination of these equivalents of bases and acids, as by tracing the ratio of the *oxygen* contained in the base to that contained in the acid. If we take *b* to be the number of equivalents of oxygen in the base, and *a* the number in the acid, the ratio between those ($b : a$) will always express the most important chemical relations of a silica-salt. For instance, in the simple silicate *Wollastonite* ($\dot{\mathrm{Ca}}$) $\ddot{\mathrm{Si}}$ there is one equivalent of oxygen in the base and two in the acid, hence $b : a :: 1 : 2$. In the compound silicate *Orthoclase* ($\dot{\mathrm{K}}\ \ddot{\mathrm{Si}}^3 + \dddot{\mathrm{Al}}\ \ddot{\mathrm{Si}}^3$) $b : a :: 4 : 12$.

This relation can be expressed more compactly by dividing out the ratio, and taking the quotient, which we call the *oxygen-quotient* (abbreviated O.Q.). In Wollastonite O.Q. would equal $\frac{b}{a} = \frac{1}{2} = .5$; in orthoclase O.Q. $= \frac{b}{a} = \frac{4}{12} = \cdot 333$.

The following table of the principal orders of silicate-salts will give a general idea of their relations—and particularly of the relation of the monoxide ($\dot{\mathrm{R}}$) salts *to* the sesqui-oxide ($\ddot{\mathrm{R}}$) salts. It must be understood, however, that it is to a great extent theoretical,—many of the salts having no natural existence. It will be seen by this that a nomenclature devised for, and only strictly applicable to, the $\dot{\mathrm{R}}$ salts is likewise applied to the $\ddot{\mathrm{R}}$ salts, which are arranged upon the others according to their O.Q. It will likewise be observed, and should always be borne in mind, that minerals of the *same per centage* of $\ddot{\mathrm{Si}}$, may belong to very *different orders of combination.*

LIST OF THE PRINCIPAL SILICA SALTS.

	Ratio of $b : a$	O.Q.	Name of Salt.		Formulæ with Monoxide bases.	Formulæ with Sesqui-oxide bases.
1	3 : 1	3.0	Sexbasic	Basic.	$\dot{R}^6 \ddot{Si}$	$\overset{\cdots}{\cancel{R}}^2 \ddot{Si}$
2	2 : 1	2.0	Quadribasic.		$\dot{R}^4 \ddot{Si}$	$\overset{\cdots}{\cancel{R}} \ddot{Si}$
3	3 : 2	1.5	Tribasic.		$\dot{R}^3 \ddot{Si}$	$\overset{\cdots}{\cancel{R}} \ddot{Si}$
4	1 : 1	1.0	Bibasic.		$\dot{R}^2 \ddot{Si}$	$\overset{\cdots}{\cancel{R}}^2 \ddot{Si}^3$
5	3 : 4	.75	Sesquibasic.		$\dot{R}^3 \ddot{Si}^2$	$\overset{\cdots}{\cancel{R}} \ddot{Si}^2$
6	2 : 3	.666	Four-thirds basic.		$\dot{R}^4 \ddot{Si}^3$	$\overset{\cdots}{\cancel{R}}^4 \ddot{Si}^9$
7	1 : 2	.5	MONOSILICATE.	Neutral.	$\dot{R} \ddot{Si}$	$\overset{\cdots}{\cancel{R}} \ddot{Si}^3$
8	2 : 5	.4	Five-fourths silicate.	Acid.	$\dot{R}^4 \ddot{Si}^5$	$\overset{\cdots}{\cancel{R}}^4 \ddot{Si}^{15}$
9	3 : 8	.375	Four-thirds silicate.		$\dot{R}^3 \ddot{Si}^4$	$\overset{\cdots}{\cancel{R}} \ddot{Si}^4$
10	1 : 3	.333	Sesquisilicate.		$\dot{R}^2 \ddot{Si}^3$	$\overset{\cdots}{\cancel{R}}^2 \ddot{Si}^9$
11	1 : 4	.25	Bisilicate.		$\dot{R} \ddot{Si}^2$	$\overset{\cdots}{\cancel{R}} \ddot{Si}^6$
12	1 : 6	.166	Trisilicate.		$\dot{R} \ddot{Si}^3$	$\overset{\cdots}{\cancel{R}} \ddot{Si}^9$
13	1 : 8	.125	Tetrasilicate.		$\dot{R} \ddot{Si}^4$	$\overset{\cdots}{\cancel{R}} \ddot{Si}^{12}$

It will be remarked that the O.Q. of a neutral silicate is ·5 ; and that it increases as the base increases, and decreases as the silica increases : or *varies inversely as the acid.*

Besides its compactness, the expression of the order of silicate minerals by means of the O.Q. has many other advantages. (1) It affords a ready means of avoiding the confusion of the different formulæ of silicates arising from the acid having been assumed until recently as a teroxide ($\dddot{Si}$) by the principal mineralogical chemists. (2) It enables us to express exactly the condition of a large class of intermediate and altered minerals, to which no regular formulæ could be applicable ; and thus to trace the metamorphoses and genesis of many minerals and rocks. (3) And, generally, in the case of complicated minerals, it avoids the necessity of setting up formulæ which are not statements of facts, but merely "the expression of the individual views of the chemist who devised them."

Next to the O.Q., which expresses the general bearing of the base to the acid, the most important relation is the ratio, in compound salts,* that the O (oxygen) in the $\dddot{\mathrm{R}}$ bases bears to the O in the $\dot{\mathrm{R}}$ bases, —which are combined together so frequently in silicate minerals. Taking *Orthoclase* again as an example ($\dot{\mathrm{K}}\ \dddot{\mathrm{Si}}^3 + \dddot{\mathrm{Al}}\ \dddot{\mathrm{Si}}^3$), here the O in $\dddot{\mathrm{R}}$: O in $\dot{\mathrm{R}}$ :: 3 : 1. In *Garnet*, a mineral of most variable constitution, this ratio is also constant at 1 : 1. In all minerals, however, this relation cannot be accurately ascertained; for in those containing Iron or Manganese, the determining of the state of oxidation in which they exist † in combination is a point attended with much difficulty. This relation of the O in $\dddot{\mathrm{R}}$: O in $\dot{\mathrm{R}}$ we may call the *Oxygen ratio*.

XXV. MINERAL SPECIES AND THEIR CLASSIFICATION.—The grouping together of mineral species, on a scientific system, is attended, as I have already mentioned, with no small difficulty. In the descriptive list of rock-minerals which follows, I have arranged them, as already indicated, into (1) Elements and Binary-Compounds; (2) Carbonates, Sulphates, and Borate; and (3) Silicates.

Elements; Binary-Compounds; Carbonates, Sulphates, and Borate. —I have already, in XIV and XVI., given a list of seventeen of these substances as forming rock-minerals. I have now to extend this number by the addition of five others, making in all *twenty-two.* These five are: *Bitumen,* the variety of carbon containing hydrogen; *Opal,* or the hydrated variety of quartz; *Brown-Hematite,* or the hydrous per-oxide of iron; *Magnetite,* or magnetic-iron, a combination of protoxide and per-oxide of iron; and *Pyrrhotine,* the magnetic variety of Pyrite.

XXVI. *Silicates.*—The leading silicated minerals naturally fall into several groups or families—characterised by determinate physical characteristics and certain general chemical relations,—such as the *felspar* group, the *garnet and tourmaline* group, the *mica* group, the *hornblendic and augitic* group, and the *talc and olivine* group. But the connexion of these groups together in such a manner as to bring the whole of the silicates into one general series is a very different matter, and in a strict sense is not possible. But, if not strictly possible, there does yet seem to be in nature, with respect to these minerals, a marked series, at one pole of which are the silicates of the alcaline bases ($\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$, $\dot{\mathrm{Li}}$),—and at the other pole the silicates of the bases $\dot{\mathrm{Mg}}$, $\dot{\mathrm{Mn}}$, and $\dot{\mathrm{Fe}}$; the bases $\ddot{\mathrm{Al}}$ and $\dot{\mathrm{Ca}}$ being in a certain sense intermediate. If the simple alcaline silicates existed in nature (which, as stated, is not the case by reason of their extreme solubility), they would occupy the one pole, now occupied by the compound silicates of the alcalies with $\ddot{\mathrm{A}}$ (*felspars*);—with *talc* and *olivine* (silicates of $\dot{\mathrm{Mg}}$ and $\dot{\mathrm{Fe}}$) at the other pole. Between these extremes we may place, next the felspars, the *garnet* group; then the *micas*; and, next the talc group, the *hornblendes* and *augites*.

---

* "The vast mass of minerals are made up of compound silicates." See XIX. p. 57.

† That is, whether they exist as $\dddot{\mathrm{Fe}}$, $\dddot{\mathrm{Mn}}$, or $\dot{\mathrm{Fe}}$, $\dot{\mathrm{Mn}}$.

Felspar group.—The felspars are essentially silicates (of various orders) of $\ddot{\mathrm{Al}}$ and the $\dot{\mathrm{R}}$ bases, $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$, $\dot{\mathrm{Li}}$, and $\dot{\mathrm{Ca}}$, having the constant oxygen ratio between the Al and the $\dot{\mathrm{R}}$ bases of 1 : 3. The order of these silicates, and the consequent proportion of acid, varies very widely; in Petalite, containing the most $\ddot{\mathrm{Si}}$, the O.Q = ·25; while in Anorthite, containing the least $\ddot{\mathrm{Si}}$, it is as high as 1.0. Thus the felspars differ among themselves in the proportion of $\ddot{\mathrm{Si}}$ they contain, and in the replacement of the alcaline bases and $\dot{\mathrm{Ca}}$ for each other; the only constant relation being the oxygen ratio of the $\ddot{\mathrm{Al}}$ and the $\dot{\mathrm{R}}$ bases. The most recent analyses show that *all* felspars contain both $\dot{\mathrm{K}}$ and $\dot{\mathrm{Na}}$, but the proportions are very variable, the $\dot{\mathrm{Na}}$ almost disappearing in some, as *orthoclase*, and the $\dot{\mathrm{K}}$ in others, as *albite*. The $\dot{\mathrm{Ca}}$ felspars seem to be the source of a class of hydrous silicates called *zeolites*. The species of the felspar group have a very striking physical similarity, unmistakeable in practice, but not very readily defined.*

Garnet and Tourmaline group.—This group, in the list of minerals, extends from Andalusite to Cordierite. It is characterised by the absence, or only trifling quantities, of alcalies in its species.

---

* L'expression de famille de felspaths est défectueuse. En effet, les espèces qui la constituent n'appartiennent pas au même système crystallin; la composition, différente pour quelques-uns sous le rapport des éléments, est atomiquement différente pour la plupart: en sorte qu'il n'existe de rapprochement entre eux ni par la forme ni par la composition. Les caractères extérieurs sont, il est vrai, tellement analogues, que la reconnaissance de ces espèces est une des plus grandes difficultés de la minéralogie. En outre, les formes quoique differentes sous le rapports des systèmes auquels elles appartiennent sont très-rapprochées par leurs angles. La couleur, l'éclat, la dureté, le poids spécifique, presque les mêmes pour ces minéraux, augmentent leur analogie: leur réunion en un group est donc fondée plutôt sur la difficulté qu'on éprouve à les reconnaître que sur les principes philosophiques. *Coquand*, p. 4.

Mica group.—The most diverse compounds may occur in the form of *mica.* The following table (from Bischof) of maximum and minimum contents shows how great this diversity may be, combined with great uniformity of physical character.

	Maximum.	Minimum.
Silica	71	36
Alumina	38	6
Protoxide Iron }	36	0
Peroxide Iron }		
Magnesia	29	0
Potash	14	2
Lithia	5.7	0
Fluorine	10.4	0

The three regular mica species are *Potash-mica, Magnesia-mica,* and *Lithia-mica.* They contain essentially $\dddot{\mathrm{Al}}$, and $\dot{\mathrm{K}}$, and (in the two first-named varieties) $\dot{\mathrm{Fe}}$, and usually some water. *Chlorite* and *Ripidolite* are physically allied to the micas, but they differ chemically in not containing an alcaline base.

Hornblendic and Talc groups.—These extend from *Wollastonite,* a simple silicate of $\dot{\mathrm{Ca}}$, to *Talc* and *Olivine,* essentially silicates of $\dot{\mathrm{Mg}}$ with a small proportion of $\dot{\mathrm{Fe}}$. The minerals of these groups occupy the opposite end of the series to the felspars, and in geological importance are next to that group.

XXVII. *Instability of Mineral Species.*—Within the narrow limits in which these papers are necessarily confined, it is impossible even to indicate many of the important physical and chemical relations of minerals, and the different theories of genetic origin deduced from them. I shall, however, give a few extracts illustrating Bischof's theory of the instability, and consequently slow cyclical changes, of mineral species, which of late years has attracted so much attention and discussion in Germany; and which, if established, will throw so much light upon the genesis and metamorphism of rocks. The extracts are from the Cavendish Society's translation of his "Chemical and Physical Geology."

> "Strictly speaking, we do not know with regard to any single mineral whether it is still in its original condition, or has been more or less altered. . . . The alteration of a mineral is an extremely slow process. The material changes go on so gradually that they are not chemically recognisable until after long periods of time. In the analysis of a mineral in which such changes have already commenced, especially by the addition of new constituents, although in very minute quantities, it is not unlikely to happen that they may be considered as accidental

hese new constituents, introduced in the course of time, are certainly foreign to e mineral in its original condition, and are on that account to be deducted. ince, however, alterations seldom take place merely by addition, but more freuently by loss of constituents, it is likewise requisite that, in the latter case, e quantities lost should be added . . this is seldom possible. . . These examples ill suffice to show the importance of the minute quantities of substances present n minerals, and generally considered as accidental. . . . They then no longer ppear as accidental, but indicate *the transition of one mineral into others*, and lay efore us clearly the genetic part of the conversion-process. . . . It is but rarely hat the chemist is able to produce artificially the changes observed in nature; nd, in order to trace the various stages of these natural processes, there remains no other course for him to pursue than to ascertain by analysis the increase of the non-essential and the decrease of the essential constituents; and, from the nature of the former, to draw conclusions as to the processes which were going on in the mineral when formed. . . . Cordierite is the starting-point of a whole series of alterations, finally ending in Mica. . . . It will scarcely ever be possible to convert Augite, Olivine, and Hornblende into Serpentine in our laboratories; but, when we find Serpentine in the form of these minerals, this fact is sufficient evidence that such a conversion can take place. . . . The Silicates that are most readily decomposed are generally those containing lime, protoxide of iron, and manganese. . . . Minerals consisting chiefly of Silicates of Alumina and Magnesia, which are the most stable of minerals, are less liable to decomposition. . . . The Silicates least liable to decomposition are chiefly such as have originated from the alterations of the less stable Silicates; so that they may be termed the *final products* of alteration. They are not liable to undergo any further alteration by means of the atmospheric agents. They may be either compound or simple Silicates,—Mica, Chlorite, Serpentine, Asbestos; Steatite, Talc, Clay, or Kaolin. * * * The most remarkable product of mineral alteration is unquestionably mica. . . . It is scarcely inferior to any in stability. . . . These minerals are not the only *final products* of alteration; there are, besides, Quartz in its various modifications, oxides, hydrates, and carbonates, incapable of higher oxidation.

"The cyclical character which is so generally recognisable in the alteration of minerals suggests the question, whether the last-mentioned minerals, which have been spoken of as *final products* of alteration, may not really be particular stages of wider cycles of alteration. It is certain that there is a limit to their duration; those that are most stable among them—the silicates of alumina and magnesia—may under certain conditions become the starting points of other metamorphic processes. If the silicates of magnesia were dissolved and carried away by water, they would take part in the formation of new minerals. There are likewise means by which the peroxide of iron and quartz may be again brought within the cycle of alteration."

DESCRIPTIVE LIST OF THE ROCK-FORMING MINERALS.

The *oxygen-quotient* is placed after the name of the species in square brackets, thus [ ].

The name of each species is followed by its synonyms and varieties. The synonym is separated from the name of the mineral by a *comma;* the variety by a *semicolon*.

The per-centage of constituents is put in brackets after the chemical symbol of the constituent. Thus $\dot{K}$ (5) means that the per-centage of soda is 5 per cent.

A. ELEMENTS AND BINARY COMPOUNDS.

1. GRAPHITE. The only regular rock-mineral formed of *Carbon* is Graphite, of which *Diamond* is the transparent variety. It often contains a variable quantity of iron, and even the purest varieties have traces of

earthy matter: in the impure varieties the quantity of iron, lime, and alumina amounts, at times, to as much as 37 per cent. But *Carbon* is most important as the foundation of the *Coal* family, divided into three species,—*Anthracite*, *Common-coal*, and *Brown-coal* or *Lignite*: these, however, are more rocks than minerals, and will be described as such. The bituminous variety of *carbon*, formed by its combination with *hydrogen*, is classed separately as

2. BITUMEN; *Naphtha; Petroleum; Asphaltum.* Contains about 12 per cent. of hydrogen. Naphtha, the purest variety, is liquid; it becomes thick by exposure, and is converted into Petroleum. Asphaltum is the solid variety.
3. SULPHUR.
4. WATER; *Ice; Firn* or *Névée.* $\dot{\mathrm{H}}$.
5. CORUNDUM; *Emery.* $\dddot{\mathrm{Al}}$. The granular and massive variety is Emery. The opaque crystalline variety is Corundum; the transparent crystalline blue and red varieties are respectively *Sapphire* and *Ruby.*
6. QUARTZ; *Jasper, Hornstone or Chert.* $\dddot{\mathrm{Si}}$. One of the most abundant minerals in nature. The pure transparent variety is *Rock-crystal,* and the blue and yellow Amethyst and Topaz. *Jasper* is the variety variously coloured by the oxides of iron principally. *Hornstone* or *Chert* are names given to compact quartz substances.
7. OPAL; *Chalcedony; Flint.* $\dddot{\mathrm{Si}} + \dot{\mathrm{H}}$. Compact or uncleavable quartz. Silica with 5 to 12 per cent. of water. *Hyalite* is the glassy transparent variety, and there are various coloured ones. The siliceous deposits from geysers and other hot springs are of this mineral. Opal differs from quartz, besides its containing water, by its much lower specific gravity, inferior hardness, simple refraction, and other chemical characters. *Chalcedony* and *Flint* are usually classed as anhydrous silica, but Fuchs considers them to be a mixture of quartz and opal. He consequently divides compact quartz into two kinds: the one containing opal, like chalcedony and flint; and the other free from opal, like chert. Bischof considers rock-crystal and opal as the final members of a series of siliceous minerals; the former perfectly crystallized, the latter perfectly amorphous.
8. HEMATITE, *Specular-iron.* $\dddot{\mathrm{Fe}}$. The crystalline variety with metallic lustre is usually called specular-iron (*Fer oligiste*). It is an abundant form of iron, and has many sub-varieties passing into each other.
9. BROWN HEMATITE, *Limnite; Goethite;* with many sub-varieties. $\dddot{\mathrm{Fe}} + \dot{\mathrm{H}}$. Hydrous per-oxide of iron. Limnite and Goethite are strictly different minerals, the former containing 14, and the latter 10 per cent. of water.
10. MAGNETITE, *Magnetic Iron.* A combination of 1 atom of per-oxide

and 1 atom of protoxide of iron. $\dddot{\overline{Fe}}\,\dot{Fe}$. An important and widely distributed rock-constituent.

11. ROCK-SALT. Na Cl, but often mixed with many impurities. A most widely distributed mineral. Haloid.

12. FLUOR, *Fluor-spar*. Ca F. A haloid mineral, more a vein- than a rock-constituent.

13. PYRITE, *Iron-pyrites*. $\overset{\prime\prime}{Fe}$.

14. PYRRHOTINE, *Magnetic pyrites*. $\overset{\prime}{Fe}{}^5\,\overset{\prime\prime\prime}{\overline{Fe}}$. Unimportant as a rock-mineral.

B. CARBONATES, SULPHATES, AND BORATE.

15. CALCITE, *Calc-spar, Arragonite*. $\dot{Ca}\,\ddot{C}$. This important mineral has many varieties. The transparent one is Iceland-spar. *Arragonite* is strictly a different mineral, although identical in chemical composition: it is not a rock-forming mineral. Haloid.

16. MAGNESITE. $\dot{Mg}\,\ddot{C}$. A haloid mineral. Unimportant.

17. DOLOMITE, *Bitter-spar*. $\dot{Ca}\,\ddot{C}\,\dot{Mg}\,\ddot{C}$. Haloid mineral; very important, forming the base of whole mountain-masses of Magnesian Limestone.

18. CHALABITE, *Siderite, Sparry-iron*. $\dot{Fe}\,\ddot{C}$. An important ore of iron, but always mixed with some impurities.

19. ANHYDRITE, *Karstenite*. $\dot{Ca}\,\dddot{S}$. Haloid mineral. Occurs generally with gypsum.

20. GYPSUM. $\dot{Ca}\,\dddot{S} + \dot{H}^2$. Haloid mineral; very important; the most abundant of the sulphates. The transparent variety is *Selenite;* and the white compact variety, Alabaster.

21. BARYTE, *Heavy-spar*. $\dot{Ba}\,\dddot{S}$. Haloid mineral; more vein- than rock-forming. Not to be confounded with *Witherite*, Carbonate of Baryta.

22. BORACITE. $\dot{Mg}^3\,\dddot{B}^4$. An unimportant rock-mineral. Haloid.

C. SILICATES.

23. ORTHOCLASE, *Potash-felspar; Adularia; Sanidine* [.333]. Is the most important felspar species. $\dot{K}\,\dddot{Si}^3 + \dddot{\overline{Al}}\,\dddot{Si}^3$ where $\dot{K} = 15$ per cent.; but it always contains more or less $\dot{Na}$. The transparent variety is *Adularia; Sanidine*, or glassy felspar, is characteristic of the volcanic rocks, and contains more $\dot{Na}$ than Orthoclase. This felspar decomposes into *kaolin;* the alteration consists in the removal of the alkalies together with a portion of the $\dddot{Si}$, while water is introduced, producing a hydrated silicate of $\dddot{\overline{Al}}$. The gradual decomposition of the original orthoclase is indicated by the increase of the O.Q., which in Kaolin reaches .75.

24. LEUCITE, *Amphigene* [.5]. Essentially $\dot{K}\,\dddot{Si} + \dddot{\overline{Al}}\,\dddot{Si}^3$. $\dot{K}$ (21); generally contains some $\dot{Na}$. This mineral is almost exclusively found in

volcanic rocks. From pseudomorphs, we find Leucite is often converted into Sanidine. In this alteration the $\dddot{\mathrm{Si}}$ remains untouched, and the $\dddot{\mathrm{Al}}$ and alcalies are removed in combination as alcaline aluminates.

25. ALBITE, *Soda-felspar*, *Pericline* [.333]. A very important felspar species. Composition $\dot{\mathrm{Na}}\ \dddot{\mathrm{Si}}^3 + \dddot{\mathrm{Al}}\ \dddot{\mathrm{Si}}^3$. $\dot{\mathrm{Na}}$ (10); but almost always containing some $\dot{\mathrm{K}}$. From the preponderance of $\dot{\mathrm{Na}}$, this felspar is more liable to decompose than Orthoclase; and is consequently readily converted into Kaolin, the O.Q. increasing as decomposition advances.

26. NEPHELINE; *Elæolite* [1.0]. Essentially a silicate of $\dddot{\mathrm{Al}}$, $\dot{\mathrm{Na}}$ (15), $\dot{\mathrm{K}}$ (5) with a small quantity of $\dot{\mathrm{Ca}}$. The white variety is Nepheline and the coloured *Elæolite*. They are not abundant minerals.

27. RYACOLITE [.666]. A glassy felspar. A silicate of $\dddot{\mathrm{Al}}$, $\dot{\mathrm{Na}}$ (10.5), $\dot{\mathrm{K}}$ (6), and $\dot{\mathrm{Ca}}$.

28. OLIGOCLASE, *Soda-spodumene* [.444]. Essentially a silicate of $\dddot{\mathrm{Al}}$, $\dot{\mathrm{Na}}$ (8), $\dot{\mathrm{Ca}}$ (2—3), almost always some $\dot{\mathrm{K}}$. Like orthoclase and albite, is decomposed into kaolin. An important felspar species.

29. ANDESINE [.5]. A mineral resembling albite, with which it was formerly classed: it is found in the Andes. A silicate of $\dddot{\mathrm{Al}}$, $\dot{\mathrm{Na}}$ (6), $\dot{\mathrm{Ca}}$ (5), and $\dot{\mathrm{K}}$ (1).

30. SPODUMENE, *Triphane* [.5]. Essentially a silicate of $\dddot{\mathrm{Al}}$, $\dot{\mathrm{Li}}$ (4—7), and some $\dot{\mathrm{Na}}$.

31. PETALITE [.25]; *Castor*. Essentially a silicate of $\dddot{\mathrm{Al}}$, $\dot{\mathrm{Li}}$ (3), and $\dot{\mathrm{Na}}$ (2.5). Castor is the crystallised variety found in Elba, and differs from Petalite in the absence of $\dot{\mathrm{Na}}$.

32. LABRADORITE [.666] An important felspar species. Essentially a silicate of $\dddot{\mathrm{Al}}$, $\dot{\mathrm{Ca}}$ (11), and $\dot{\mathrm{Na}}$ (4), perhaps also $\dot{\mathrm{K}}$, as it is generally present. Iron is rarely absent. Distinguished from other felspars by its great liability to decomposition; which results either from the total elimination of the $\dot{\mathrm{Ca}}$ or a partial elimination of the $\dddot{\mathrm{Si}}$. Many zeolites appear to be the products of the decomposition of Labradorite.

33. ANORTHITE, *Christianite* [1.0], *Saussurite* [.8]. An important felspar. Normally a silicate of $\dddot{\mathrm{Al}}$ and $\dot{\mathrm{Ca}}$ (16), with small quantities of $\dot{\mathrm{K}}$, $\dot{\mathrm{Na}}$, and generally some $\dot{\mathrm{Mg}}$. The amount of $\dot{\mathrm{Ca}}$ varies greatly, and diminishes as the alcalies and $\dot{\mathrm{Mg}}$ increase. *Saussurite* is a mineral of irregular composition, and is supposed to be an impure Anorthite or Labradorite. It occurs in the rock Gabbro; and Bischof considers its unequal composition to be due to the effect of the decomposition of the other minerals in that rock.

34. SODALITE. HAÜYNE. Sodalite is a silicate of $\dddot{\mathrm{Al}}$, and $\dot{\mathrm{Na}}$ combined with Na Cl; the proportion being about $\dddot{\mathrm{Al}}$ (32), $\dot{\mathrm{Na}}$ (25), and Cl

(6). Hauyne is a silicate of $\dddot{\text{Al}}$ (26), $\dot{\text{Na}}$ (15), and $\dot{\text{Ca}}$ (9), combined with $\dddot{\text{S}}$ (12): a variety of this last mineral, called *Nosean*, has a slightly different composition, with less sulphuric acid and $\dot{\text{Ca}}$, and more $\dddot{\text{Al}}$ and $\dot{\text{Na}}$. O.Q. of all these minerals is about 1.0.

35. **Zeolites.** These minerals are hydrated silicates of $\dddot{\text{Al}}$, $\dot{\text{Ca}}$, and alcalies, or seemingly hydrated lime-felspars. They all contain $\dddot{\text{Al}}$ except 3 (*Apophyllite, Damourite*, and *Datolite*); and all contain $\dot{\text{Ca}}$ except 3 (*Analcime, Natrolite*, and *Baryta-harmotome*). The following list includes all the principal zeolites, arranged according to their constituents:—

$\dddot{\text{Al}}$, $\dot{\text{Ca}}$	Scolezite, Stilbite, Heulandite, Laumonite, Leonhardite.
$\dddot{\text{Al}}$, $\dot{\text{Ca}}$, $\dot{\text{Na}}$ . .	Thomsonite (Comptonite), Epistilbite, Faujasite, Mesolite.
$\dddot{\text{Al}}$, $\dot{\text{Ca}}$, $\dot{\text{K}}$ . . .	Chabasite, Phillipsite (Lime-harmotome) (some $\dot{\text{Na}}$).
$\dddot{\text{Al}}$ . . . $\dot{\text{Na}}$ . .	Analcime, Natrolite (Mesotype).
$\dddot{\text{Al}}$ . . . . . $\dot{\text{Ba}}$.	Baryta-harmotome.[*]
$\dddot{\text{Al}}$, $\dot{\text{Ca}}$, $\dot{\text{Ba}}$, and Strontia.	Brewsterite.[*]
. . $\dot{\text{Ca}}$, $\dot{\text{K}}$ . . .	Apophyllite, Damourite.
. . $\dot{\text{Ca}}$	Datolite (with Boracic acid).

36. **Andalusite** [1.33]; *Chiastolite*. Essentially an anhydrous silicate of $\dddot{\text{Al}}$ with very often some $\dddot{\text{Fe}}$. *Chiastolite* is a variety with a peculiar internal structure. Bischof supposes Andalusite to originate, in many instances, from felspars. In the conversion of felspars into kaolin there is a diminution of $\dddot{\text{Si}}$, and an increase of $\dddot{\text{Al}}$; and, if this process were continued further, the composition of Andalusite would be ultimately attained. From pseudomorphs, we find that Andalusite and Chiastolite are convertible into Steatite, and the latter (Chiastolite) into Talc.

37. **Kyanite**, *Disthene* [1.5]. Composition essentially the same as that of Andalusite, which mineral is found, by pseudomorphs, to be convertible into Kyanite; this alteration consists in the elimination of the extra $\dddot{\text{Si}}$, which gives the lower O.Q. to Andalusite, and may be considered as a continuation of the before-mentioned process of alteration of felspars into Andalusite.

38. **Wernerite**, *Scapolite* [.75]; *Meionite* [1.0]. This mineral is essentially a silicate of $\dddot{\text{Al}}$ and $\dot{\text{Ca}}$ (17), but almost always contains alcalies, either $\dot{\text{Na}}$ alone, or $\dot{\text{Na}}$ with a small proportion of $\dot{\text{K}}$: the alcalies

---

[*] These obscure minerals are noticeable as being the only silicates of Baryta known in the mineral kingdom.

replace the $\dot{C}a$; and $\dddot{\overline{F}}e$ and $\dddot{\overline{M}}n$ sometimes also replace the $\dddot{\overline{A}}l$ in small quantities. *Meionite*, the transparent variety, is essentially the same in composition, although in a different order of silicate, by which it has less $\dddot{S}i$, and consequently a higher O.Q. According to Bischof, there is no mineral known capable of undergoing more numerous and diverse alterations than Wernerite.

39. EPIDOTE, *Pistazite* [1.0]; *Zoisite.* Consists essentially of a silicate of $\dddot{\overline{A}}l$ and $\dot{C}a$, the former base being replaced, often largely, in the different varieties by $\dddot{\overline{F}}e$ and $\dddot{\overline{M}}n$, and the $\dot{C}a$ by $\dot{F}e$. Iron-epidote or *Pistazite*, the most common variety, has $\dot{C}a$ (22), $\dddot{\overline{F}}e$ (13), and $\dot{F}e$ (5). *Zoisite*, or lime-epidote, has $\dot{C}a$ (21), $\dddot{\overline{F}}e$ (5), and often a variable amount of $\dot{F}e$; it is usually supposed to be distinguished, as a lime-epidote, by absence of $\dot{F}e$; but, according to Nicol, is rather characterised by the small amount of $\dddot{\overline{F}}e$ replacing $\dddot{\overline{A}}l$. Manganese-epidote is distinguished by the replacing of the $\dddot{\overline{A}}l$ by $\dddot{\overline{M}}n$ (17) with $\dot{C}a$ (20), $\dddot{\overline{F}}e$ (9). This mineral, it will be seen, is especially marked by the frequent and large interchange of the isomorphous $\dddot{\overline{R}}$ bases, which occurs in a minor degree in Wernerite.

40. TOURMALINE, *Schorl* [1.0 or .833]. This is one of the most complex of the silicated minerals, including, in its different varieties, in greater or less proportions, *all* the $\dddot{\overline{R}}$ and $\dot{R}$ bases named in XIX. as combining with $\dddot{S}i$ to form rock-minerals, and containing, besides, $\dddot{B}$ (which is supposed to act as an acid and replace $\dddot{S}i$), and also a certain quantity of Fl. No general formula has yet been found applicable to the different varieties of this mineral; and the consistency of its form through changes which cannot be accounted for by isomorphism has suggested many difficulties. The O.Q. is 1.0 or .833, according as we regard Boracic acid as B or $\ddot{B}$*; but, at whichever number we take it, it only varies, through all the varieties, within very narrow limits, and consequently the ratio of the oxygen in the bases, as a whole, is nearly constant with that of both the acids taken together. Rammelsberg also considers the oxygen in $\dddot{B}$ to have the constant ratio to that in $\dddot{S}i$ of 1 : 3.5; and, however the amount of $\dddot{S}i$ varied, he found this proportion unchanged, which he considers as indicative of the substitution of the acids for each other.

The oxygen-ratio in the $\dot{R}$ and $\dddot{\overline{R}}$ bases varies very widely. Rammelsberg has been able to arrange the different proportions into five groups, according to the nature of this ratio; and the arrangement is also found to correspond with the leading physical varieties of the mineral.

---

* See Dr. Phipson's remarks in July number of THE GEOLOGIST (vol. I. p. 299) on this acid.

	A	B	C	D	E
Monoxide bases	1	1	1	1	1
Sesqui-oxide bases	3	4	6	9	12
Silicic and Boracic acid . .	5	6	8	12	15
O.Q. ($\dddot{\mathrm{B}}$)	0.8	0.836	0.875	0.833	0.866

A. Yellow and brown Tourmaline, with little $\overset{\dots}{\overline{\mathrm{Fe}}}$ (2) and the largest quantity of $\dot{\mathrm{Mg}}$ (11); together with $\dddot{\mathrm{B}}$ (9), Fl (2), $\dot{\mathrm{Na}}$ (2), $\dot{\mathrm{Ca}}$ (1), and some $\dot{\mathrm{K}}$.

B. Black Tourmaline, containing a mean proportion of $\overset{\dots}{\overline{\mathrm{Fe}}}$ (7) and $\dot{\mathrm{Mg}}$ (8); together with $\dddot{\mathrm{B}}$ (8), Fl (2), $\dot{\mathrm{Na}}$ (2), $\dot{\mathrm{Ca}}$ (1), and some $\dot{\mathrm{K}}$.

C. Blackest, with largest proportion of Iron, $\overset{\dots}{\overline{\mathrm{Fe}}}$ (8), $\dot{\mathrm{Fe}}$ (6), and least of $\dot{\mathrm{Mg}}$ (2); together with $\dddot{\mathrm{B}}$ (8), Fl (2), $\dot{\mathrm{Na}}$ (1), with some $\dot{\mathrm{Ca}}$ and $\dot{\mathrm{K}}$.

D. Violet, blue, green, generally containing some $\dot{\mathrm{Li}}$, $\overset{\dots}{\overline{\mathrm{Fe}}}$ (5), and $\dot{\mathrm{Mn}}$ (3); together with $\dddot{\mathrm{B}}$ (7), $\dot{\mathrm{Na}}$ (2), Fl (2), $\dot{\mathrm{Mg}}$ (1), with some $\dot{\mathrm{Ca}}$ and $\dot{\mathrm{K}}$.

E. Red Tourmaline, with $\dot{\mathrm{Li}}$ (1) but no Iron; together with $\dddot{\mathrm{B}}$ (8), Fl (2.5), $\dot{\mathrm{Na}}$ (2), $\dot{\mathrm{K}}$ (1), and $\dot{\mathrm{Mg}}$ (1).

The whole of Rammelsberg's analyses, classed on these five divisions, are to be found in Brooke and Miller's edition of "Phillips's Mineralogy." *Schorl*, the black variety, is the most abundant.

Hermann divides all the varieties of Tourmaline into three species, with the following formulæ, the $\dot{\mathrm{R}}$ bases being placed in the order of quantity, and the $\overset{\dots}{\overline{\mathrm{Al}}}$ being assumed to be replacable by $\overset{\dots}{\overline{\mathrm{Fe}}}$.

1. Schorl . . $(\dot{\mathrm{Fe}}, \dot{\mathrm{Mg}}, \dot{\mathrm{Li}}, \dot{\mathrm{Na}})\ \dddot{\mathrm{B}} + \overset{\dots}{\overline{\mathrm{Al}}}\ \dddot{\mathrm{Si}}$. O.Q. = 1.0
2. Achroite . $2\,(\dot{\mathrm{Na}}, \dot{\mathrm{Li}}, \dot{\mathrm{Mg}}, \dot{\mathrm{Mn}})\ \dddot{\mathrm{B}} + 3\,\overset{\dots}{\overline{\mathrm{Al}}}{}^3\ \dddot{\mathrm{Si}}{}^3$. O.Q. = .9090
3. Rubellite $2\,(\dot{\mathrm{Na}}, \dot{\mathrm{Li}}, \dot{\mathrm{Mn}}, \dot{\mathrm{Mg}})\ {}^2\dddot{\mathrm{B}} + 3\,\overset{\dots}{\overline{\mathrm{Al}}}{}^3\ \dddot{\mathrm{Si}}{}^3$. O.Q. = 1.0

assuming the Boracic acid to be a binoxide.

We find by pseudomorphs that Tourmaline is convertible into Mica, Chlorite, and Steatite. In these alterations $\overset{\dots}{\overline{\mathrm{Al}}}$ is always separated, until in Steatite, the final product of alteration, it disappears. Besides this, the decomposition takes place in two different directions: in the conversion into Mica, alcalies are introduced; while in the conversion into Chlorite and Steatite, the alcalies present in Tourmaline are separated, and the $\dot{\mathrm{M}}\mathrm{g}$ constantly increased.

41. GARNET [1.0]. This mineral, so widely variable in its components, is yet—unlike Tourmaline—remarkable for the regularity of its chemical relations, all the various replacements of its constituents being in strict accordance with the doctrine of isomorphism. Its O.Q. is constant, and likewise the oxygen-ratio of $\dot{\mathrm{R}}$ to $\ddot{\mathrm{R}} = 1:1$, answering to the formula $\dot{\mathrm{R}}^3\,\ddot{\mathrm{S}}\mathrm{i}^2 + \ddot{\mathrm{R}}\,\ddot{\mathrm{S}}\mathrm{i}$, where $\dot{\mathrm{R}}$ is $\dot{\mathrm{C}}\mathrm{a}$, $\dot{\mathrm{F}}\mathrm{e}$, $\dot{\mathrm{M}}\mathrm{g}$, $\dot{\mathrm{M}}\mathrm{n}$; and $\ddot{\mathrm{R}}$, $\ddot{\mathrm{A}}\mathrm{l}$ or $\ddot{\mathrm{F}}\mathrm{e}$. The following examples will illustrate the common variations. The common (*alumina-lime*) garnet contains principally $\ddot{\mathrm{A}}\mathrm{l}$ (20), $\dot{\mathrm{C}}\mathrm{a}$ (32), with $\ddot{\mathrm{F}}\mathrm{e}$ (8). The noble (*alumina-iron*) garnet (*Almandine*), principally $\dot{\mathrm{F}}\mathrm{e}$ (40), $\ddot{\mathrm{A}}\mathrm{l}$ (20). The black (*magnesian*) variety $\ddot{\mathrm{A}}\mathrm{l}$ (22), $\dot{\mathrm{M}}\mathrm{g}$ (13), $\dot{\mathrm{F}}\mathrm{e}$ (9), $\dot{\mathrm{M}}\mathrm{n}$ (6), $\dot{\mathrm{C}}\mathrm{a}$ (6). The *manganese-garnet* contains $\dot{\mathrm{M}}\mathrm{n}$ (33), $\ddot{\mathrm{A}}\mathrm{l}$ (18), $\dot{\mathrm{F}}\mathrm{e}$ (15). The *iron-lime* variety has $\dot{\mathrm{F}}\mathrm{e}$ (31), $\dot{\mathrm{C}}\mathrm{a}$ (28), $\dot{\mathrm{M}}\mathrm{g}$ (7). Two other varieties (Pyrope and Uwarowite) contain respectively 9 per cent. and 23 per cent. of the oxide of Chromium. Thus every important base, both protoxide and sesqui-oxide, which each in their characteristic varieties reach to a large per centage, in turn disappears, being replaced by their isomorphs.

Like all minerals containing considerable quantities of $\dot{\mathrm{C}}\mathrm{a}$ and $\dot{\mathrm{F}}\mathrm{e}$, the varieties of Garnet with these bases are very liable to decomposition. The principal pseudomorphs of Garnet are Chlorite, Serpentine, and Steatite.

42. IDOCRASE, *Vesuvian* [1.0]. Like Garnet, to which Idocrase bears a great similarity, and with which it is frequently associated, the O.Q. is 1.0; but the oxygen-ratio of the $\dot{\mathrm{R}}$ to $\ddot{\mathrm{R}}$ bases is probably different, or nearer 3 : 2. The mineral consists essentially of a silicate of $\dot{\mathrm{C}}\mathrm{a}$ (33), $\ddot{\mathrm{A}}\mathrm{l}$ (16), $\ddot{\mathrm{F}}\mathrm{e}$ (7), and $\dot{\mathrm{M}}\mathrm{g}$ (5), replacing each other, and with sometimes a little $\dot{\mathrm{F}}\mathrm{e}$ and $\dot{\mathrm{M}}\mathrm{n}$.

43. CORDIERITE, *Iolite*, *Dichroit* [.8]; *Pinite; Fahlunite;* and others. Cordierite is not frequently met with: its essential constituents are a silicate of $\ddot{\mathrm{A}}\mathrm{l}$ (31), $\dot{\mathrm{M}}\mathrm{g}$ (10), and $\ddot{\mathrm{F}}\mathrm{e}$ (8). The oxygen-ratio of the $\dot{\mathrm{R}}$ and $\ddot{\mathrm{R}}$ bases is 2 : 3. This mineral is principally important by being regarded by Haidinger, Bischof, and others as the initial member of a series of minerals, including Fahlunite and Pinite, and ending in Mica. The alteration to which Cordierite is subject has one essential feature,—the elimination of the $\dot{\mathrm{M}}\mathrm{g}$, and the introduction of water and alcalies. In one series of alterations the water only is introduced; but in the other (which includes *Fahlunite* and *Pinite*) the alcalies come in, and attain the maximum in pinite, which has $\dot{\mathrm{K}}$ (8). Rammelsberg considers the ratio of oxygen in the $\ddot{\mathrm{S}}\mathrm{i}$ and $\ddot{\mathrm{A}}\mathrm{l}$

to be the same (5 : 3) in Pinite as in Cordierite. Cordierite is (with Olivine) one of the few minerals containing silicate of Magnesia liable to decomposition.

44. **Mica**, *Potash- or Biaxal Mica* [.866]. Essentially a silicate of $\dddot{\bar{\mathrm{Al}}}$ (34), $\dot{\mathrm{K}}$ (9), and $\dddot{\bar{\mathrm{Fe}}}$ (6), sometimes with $\dot{\mathrm{Fe}}$, $\dot{\mathrm{H}}$, and $\dot{\mathrm{Mn}}$, but very variable.

45. **Biotite**, *Magnesia- or Uniaxal Mica* [1.0]. Very variable, but essentially a silicate of $\dot{\mathrm{Mg}}$ (19), $\dddot{\bar{\mathrm{Al}}}$ (17), $\dot{\mathrm{K}}$ (9), $\dddot{\bar{\mathrm{Fe}}}$ (8), and generally some $\dot{\mathrm{H}}$ and $\dot{\mathrm{Fe}}$.

46. **Lipidolite**, *Lithia-mica* [1.0]. Essentially a silicate of $\dddot{\bar{\mathrm{Al}}}$ (26), $\dot{\mathrm{K}}$ (9), $\dot{\mathrm{Li}}$ (4) with hydrofluoric acid (5), and generally $\dot{\mathrm{Mn}}$, and often $\dot{\mathrm{Fe}}$ and $\dot{\mathrm{H}}$.

47. **Chlorite** [1.33]. A silicate of $\dot{\mathrm{Fe}}$ (22), $\dddot{\bar{\mathrm{Al}}}$ (20), $\dot{\mathrm{Mg}}$. (18), with $\dot{\mathrm{H}}$ (10); sometimes $\dddot{\bar{\mathrm{Fe}}}$ replacing $\dddot{\bar{\mathrm{Al}}}$; and $\dot{\mathrm{Mn}}$ in small quantities.

48. **Ripidolite** [1.5]. A silicate of $\dot{\mathrm{Mg}}$ (34), $\dddot{\bar{\mathrm{Al}}}$ (16), $\dot{\mathrm{Fe}}$ (4), $\dddot{\bar{\mathrm{Fe}}}$ (4), with $\dot{\mathrm{H}}$ (13).

49. **Wollastonite** [.5]. Essentially a silicate of $\dot{\mathrm{Ca}}$ (47), with generally a very small quantity of $\dot{\mathrm{Mg}}$, and often $\dddot{\bar{\mathrm{Fe}}}$. Supposed by mineralogists to be an Augite of the simplest kind.

50. **Augite**, *Pyroxene; Diopside; Malacolite, Sahlite;* and others [.5]. This mineral may, chemically, be separated into two classes, that containing $\dddot{\bar{\mathrm{Al}}}$ (5), including Augite proper; and the non-aluminous class, including the other varieties mentioned. Excepting this distinction, the mineral consists essentially of a silicate of $\dot{\mathrm{Ca}}$ (in nearly a constant quantity), and $\dot{\mathrm{Mg}}$ and $\dot{\mathrm{Fe}}$ in variable proportions, the former generally preponderating. *Aluminous Augite*, the most common variety, has $\dot{\mathrm{Ca}}$ (21), $\dot{\mathrm{Mg}}$ (14), $\dot{\mathrm{Fe}}$ (7), $\dddot{\bar{\mathrm{Al}}}$ (5). *Diopside* has $\dot{\mathrm{Ca}}$ (24), $\dot{\mathrm{Mg}}$ (18), $\dot{\mathrm{Fe}}$ (2), and generally small quantities of $\dot{\mathrm{Mn}}$. *Malacolite* has $\dot{\mathrm{Ca}}$ (23), $\dot{\mathrm{Mg}}$. (15), $\dot{\mathrm{Fe}}$ (7), and some $\dot{\mathrm{Mn}}$. The black iron variety, *Hedenbergite*, has $\dot{\mathrm{Ca}}$ (21), $\dot{\mathrm{Fe}}$, (24), $\dot{\mathrm{Mg}}$ (2). Augite also occurs in a fibrous state, and is then called Amianthus or Asbestos. The O.Q. of the non-aluminous class is .5; and, according to Bischof, that of the aluminous .666. The $\dddot{\bar{\mathrm{Al}}}$ in this mineral is considered to act as an acid. Augite is extremely liable to decomposition. We find by pseudomorphs that it is convertible into Mica and many other substances.

51. **Hornblende**, *Amphibole; Tremolite; Actinolite; Antophyllite;* and others [.444]. According to Gmelin, O.Q. = .416. This mineral is closely allied to Augite, but (as seen by the O.Q.) has more $\dddot{\mathrm{Si}}$, and also more $\dot{\mathrm{Mg}}$, but less $\dot{\mathrm{Ca}}$. The varieties can be divided into aluminous and non-aluminous. The aluminous are common Hornbl

Pargasite, and basaltic hornblende. General composition about $\dot{\text{Mg}}$ (15), $\dot{\text{Ca}}$ (12), $\ddot{\text{Al}}$ (10), $\dot{\text{Fe}}$ (7—10), very variable. Uralite is also an aluminous variety. The non-aluminous varieties are *Tremolite* and *Actinolite* (magnesia-lime hornblende) with $\dot{\text{Mg}}$ (24), $\dot{\text{Ca}}$ (14), and $\dot{\text{Fe}}$, amounting to (4) in Actinolite; and *Antophyllite* (magnesia-iron variety) with $\dot{\text{Mg}}$ (24), $\dot{\text{Fe}}$ (14), $\dot{\text{Mn}}$ (2). The fibrous variety, Asbestos or Amianthus, has generally the composition of Tremolite or Actinolite.

In this mineral the $\ddot{\text{Al}}$ is supposed to act partly as an acid, replacing the $\dddot{\text{Si}}$ and forming aluminates, and partly as a base; but the subject is very obscure. It is less subject to decomposition than Augite, from its containing less $\dot{\text{Ca}}$; but yet it is liable to many series of alterations.

52. HYPERSTHENE [.5]. A silicate of $\dot{\text{Mg}}$ (12—25), $\dot{\text{Fe}}$ (25—12), $\dot{\text{Ca}}$ (3), and often $\ddot{\text{Al}}$ and $\dot{\text{Mn}}$. Marked by its small contents of $\dot{\text{Ca}}$, and wide replacement by each other of $\dot{\text{Mg}}$ and $\dot{\text{Fe}}$.

53. BRONZITE [.5]. A silicate of $\dot{\text{Mg}}$ (30) and $\dot{\text{Fe}}$ (9), with often some $\dot{\text{Mn}}$ and $\dot{\text{H}}$, and sometimes $\dot{\text{Ca}}$.

54. DIALLAGE [.5]. A silicate of $\dot{\text{Mg}}$ (17), $\dot{\text{Ca}}$ (16), $\dot{\text{Fe}}$ (7), $\ddot{\text{Al}}$ (3), with $\dot{\text{H}}$ (2).

55. SERPENTINE [.75]. Many varieties. A silicate of $\dot{\text{Mg}}$ (40) and $\dot{\text{Fe}}$ (2—6), with $\dot{\text{H}}$ (12).

56. TALC; *Steatite, Speckstein* [.428 or .437]. Average composition of silicate of $\dot{\text{Mg}}$ (32), $\dot{\text{Fe}}$ (2), with $\dot{\text{H}}$ (3). *Steatite* is the compact variety, but has always a crystalline structure. Meerschaum is the amorphous variety, with four per cent. additional water.

57. OLIVINE, *Chrysolite, Peridot* [1.0]. A silicate of $\dot{\text{Mg}}$ (45) and $\dot{\text{Fe}}$ (15), with very little $\dot{\text{Mn}}$ and $\ddot{\text{Fe}}$. In the green transparent variety, *Chrysolite*, there is the highest proportion of $\dot{\text{Mg}}$ (50) and a comparative decrease of $\dot{\text{Fe}}$.

THE HÆMATITE DEPOSITS OF GLAMORGANSHIRE.

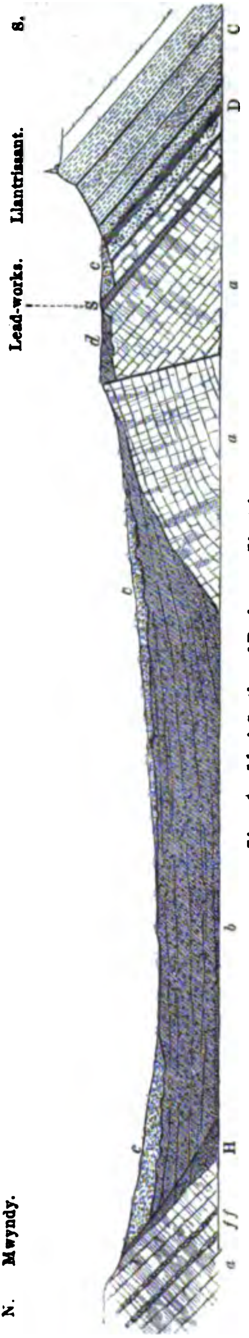
By DR. J. J. W. WATSON, F.G.S., F.S.A., Member of the North of England Institute of Mining Engineers.

DURING the last few years, the native iron-making resources of South Wales have received considerable assistance from the re-discovery and working of some very remarkable deposits of hæmatite in the county of Glamorganshire. I propose in the present article to describe two of the most important, perhaps, of those veins of ore, which are found in the districts of Llantrissant and Llanharry, near Cowbridge, and at Newton Nottage, near Bridgend;—the iron-ore in the latter locality being associated with a very large and curious deposit of manganese, chiefly psilomelane. Prefatory to this description, it may not be out of place to give a few remarks on the physical geology of the surrounding country, inasmuch as this district possesses ample materials to engage the attentive and careful examination of the geologist, particularly in relation to the origin of the mineral deposits in question. The exploitation of these hæmatite-mines will have the effect, commercially, of giving a great development and increased prosperity to the iron-manufacture in the district south of Cardiff; while, as a social result, their being worked will probably bring back to a population, at present agricultural, the mining and metallurgical occupations of the ancient fore-dwellers on the soil, and, what is most desirable, give constant occupation to a very large number of the working classes.

The stratigraphical position, as well as mode of occurrence of the ore, is similar in all three localities, being confined to the uppermost beds of the carboniferous limestone, immediately below where, in ordinary cases in this district, it is overlaid by the sub-dolomitic or calcareo-magnesian conglomerate, of equivocal age, which occupies the hollows and overlaps the edges of the limestone.

Starting from the shores of the Bristol Channel, the limesto strata roll forward to form a series of east and west anticlinals, they take their final north-east dip and disappear beneath the coal-measures. Bedded in the corresponding synclinal troughs to which this arrangement gives rise, are the nearly horizontal but much denuded strata of dolomitic conglomerate, which help to constitute a series of parallel basins, the deeper depressions in the magnesian rock being occupied by outliers of triassic marl, capped by lower lias limestone, while the more moderately denuded portions of the surface are covered up with beds of bouldered drift, which mostly exhibit imperfect stratification, with false bedding, and are often of great thickness. South-east of the belt of limestone, between Llantrissant and Llanharry, at Tregwylum, there is a protrusion of old red sandstone, showing the transition-beds with their yellow sands and the overlying lower carboniferous shales; but the real "old red" base of the South Wales coal-field commences south of Pentyrch, and, with the exception of the interruption afforded by the drift and alluvium of Taff Vale, extends thence continuously into Monmouthshire and Herefordshire. As a consequence of the geological structure, the surface of the country presents a number of narrow and shallow valleys, running mostly to the sea on the south-west; and if we look north, we may see in the foreground, trending from east to west like low crested waves on a lazy ocean, the limestone-ridges and conglomerate-bottoms, while beyond, rising in a series of dwarfed bluffs one over the other, and only to be separately distinguished in the view by the alternations of lights and shadows caused by the hills and valleys, are the basset-edges of the lower and middle groups of coal-measures with the pennant-sandstone. Turn to the south, and the same undulating country lies stretched out before us, but the crests of the waves or anticlinals now fall lower, while the swell of the strata spreads wider, until, over and beyond the last rising land, a dim misty streak terminates the scene and marks the line of the sea-shore.

The accompanying diagram represents the rocks in ideal section near Llantrissant, and illustrates the prevailing geology of the Glamorganshire sea-board. It represents one of the many undulations of the limestone, and the unconformable filling-up of the troughs by the dolomitic conglomerate. It also shows, what is here characteristic, the comparatively rapid inclination of the northern dips, as compared to the more gradual curves of the strata where the limestone rises into nticlinals, and thus establishes, apart om the inland pitch of the rock on he shores of the Channel, the true irection whence proceeded those ele- atory disturbances by which the vast nasses of this rock emerge from be- neath the coal-measures. When walk- ing over the country, what first strikes the physical geologist, is, the frequent fractured and upturned edges of the limestone-strata, wherever the summits or axes of the anticlinals are bared, either by their cropping through the soil, or by the artificial exposure of the beds, as laid open for quarrying, by the removal of the conglomerate "cap." That such masses of rock were once continuous, and the now broken beds were formerly uninterruptedly joined, does not admit of doubt; and it is interesting to notice how the old weathered surfaces of the inclined ledges—presenting marks of attrition so similar to those which are now to be observed from the action of the waves on the same rocks at the adjacent shore—are, according to their elevation, either lapped over by conglomerate, or covered with the drift-gravel. If we restore the outline of the ancient surface of the tract as it existed after, perhaps, the first convulsions, and before the land sank beneath the sea to receive the deposits of the newer rocks, by joining the figure of the "coursing" of the limestone-strata by lines proportionately curved to the prevailing "dips," a



Lign. 1.—Ideal Section of Rocks near Llantrissant.

a a a Carboniferous Limestone. b, d Magnesian conglomerate. c c c Superficial Drift. Chert Beds.
C Coal Measure. D Pennant Sandstone. H Hæmatite Deposits.

clue may be obtained which will serve to unravel something of the history of those extensive denudations which have given origin to the curious intercircling, and often perplexing, assemblage of mesozoic and ancient rocks which is presented by the geology of this part of South-Western England,—where, although organic remains are by no means abundant, the fossil-collector may, at the end of a day's search, lay side by side the characteristic indices of life-periods separated by vastly remote intervals of geologic time, gathered out of not more than half-a-dozen quarries, in the space of as few miles,—and where, in a country that hardly deserves to be called hilly, the petrologist may note, in an area of the same or even less extent, an individually-represented range of formations, from "old red" to "lower lias."

By such restorations of the breaks and curves in the limestone, it becomes at once apparent that an enormous amount of mineral matter has been destroyed and re-arranged. The coal-measures, with their coal-seams "cropping" nearly to the surface, and actually coming out to the day in places, afford perfect evidence that their collection of shales and sandstones were never originally discontinued at their present outcrop, but that, on the contrary, they form only the remnant of a more extended tract of similar strata, long since destroyed, that once covered the subjacent limestone. The elevated portions of this rock, together with the old red sandstone, formed islands and headlands, exposed to the action of breakers which, while they beat away the cliffs of the coal-measures, furnished from the harder strata those sub-angular shingles which, with the limestone-pebbles, were afterwards cemented and consolidated by a calcareous or magnesio-calcareous paste, into the dolomitic conglomerate. That this conglomerate was in part derived from these strata, is attested by the fact, that as the beds approach the coal-measures, the quantity of fragments of sandstone preponderates over those of limestone. It is also fair to assume that the softer rocks may have furnished the patches of red sands and marls afterwards thrown down in quiet places on the conglomerate. In a quarry near Pyle, about three miles from Newton Nottage, a section can be observed, where these red sands and marls rest on the denuded surfaces of the conglomerate, and are surmounted by lower lias-limestone.

In Sir H. De La Bêche's valuable paper on the "Formation of Rocks in South Wales," the dolomitic conglomerate is classed with the poikilitic or new red sandstone series, and a lithological resemblance is pointed out between this rock and consolidated beaches, the resemblance being further traced in their mode of occurrence. Messrs. Buckland and Conybeare, also, in their notice of the south-western coal-districts of England, observe that the conglomerate "generally forms a thick bank or talus near the base of those hills from the *débris* of which it has been derived; while at a distance from them it grows thinner, and at length wholly disappears." But, without actually dissenting from the presumed beach-origin of the conglomerate, I submit that the recent mining excavations in the neighbourhood of Llantrissant and Llanharry, as well as the openings and sections at Newton Nottage, exhibit so much evidence of former denudation, that there is strong reason for believing that the patches and thin coverings of the magnesian rock now presented to us, are merely the remains of a thicker formation, which has been attenuated to its present condition by aqueous causes; and, following up this view, there is nothing, in the absence of palæontological grounds, to show why this rock, which is notably magnesian in its composition, should not be the representative of the magnesian limestone of true Permian age in the North of England, and be wholly unconnected in time with the overlying sands and marls at the base of the lias. This reasoning seems further supported by the frequent cases of unconformability in the position of the latter group of rocks. In the absence of organic tests, it is fair to assume, all other things being equal, the contemporaneity of formations lithologically *related*, though not identical.

The outliers of the lias, and the scooped-out surface of the dolomite, where exposed in section, and where the hollows are seen filled with drift-gravel, mark periods of destruction. And to these we have additional witnesses in the loose blocks of the conglomerate which fret the surface of such situations as Newton Nottage Downs, and the blocks of fine soft pinkish-white argillo-quartzose stone which occur scattered over the western part of those downs.* If we follow the coast from the little fringe of limestone and conglomerate-rock at the Bathing House at Newton over the barren dunes of blown sand through which the little river Ogwr enters the sea, we come again on the same rocks; and as we leave the conglomerate, approaching Dunraven Castle, we find the lias limestone resting partly on this rock, and partly on the carboniferous limestone, without any intermediate red sands or marls, so that, even if these latter deposits existed, they must have been removed prior to the deposit of the liassic strata. But to quote other instances of the degradation of the chief rock-formations of the district is unnecessary, or to prove that the destructive action produced by moving water had been actively engaged in bringing about much of the present configuration of this portion of the surface of South Wales; it is right, nevertheless, to point out the thick-bedded gravels which, though usually classed under the general term of drift, probably represent the progress of geological events far removed from one another in time. Of these, however, one thing is certain, that in the districts in question the massive beds of sand, small, flat, and sub-angular fragments of shale,[*] which often carry proof of their original position in the roof of some ancient coal-seam by being still flecked with coaly particles,—pieces of clay-ironstone, pebbles, and patches of loamy clay which spread wide over the low grounds, in places as much as ten yards deep, are entirely composed of the *débris* of local rocks. Towards this miscellaneous collection of rock fragments, the coal-measures and the lias have contributed abundantly;[*] and although in the various oscillations of land, which most likely occurred in bygone tertiary times, the materials were more than once assorted during the varying changes of level, yet, with the exception of the results of the action of modern agents, we may look upon these gravels as evidence of the last great modification of the surface.

---

* This rock, mostly in a disintegrated state, often occupies hollows in the limestone, where it is considered to be *in situ*, and it is questionable whether it does not belong to the Millstone-grit or its equivalent. In North Staffordshire, the

The cases are not many in which we have direct evidence afforded us of a former phase in the physical geography of a country, by the finding of the remains of animals still in the same positions as those

---

hollows in the Carboniferous limestone are similarly filled at Oakamore, near Cheadle, and the argillo-siliceous sands are there largely quarried for use in the potteries, from their possessing highly refractory qualities for the manufacture of lining-tiles for the kilns.

[*] Rolled shells of a species of Gryphæa are common in the drift.

ey occupied when alive. Yet in the district I am describing, such stimony can be found, and the date, geologically, of the period when hose elevations occurred which in all probability gave arrangement o the present surface of the land, is most singularly revealed to us. Mr. David Rees, of Neath, discovered some time since some modern ittoral shells among the "attle" from a lead-vein which traverses the rop of the limestone at the Llantrissant Lead-works, from which place the shore now lies upwards of eighteen miles distant. The specimen, which is in my possession, is figured on the adjoining page (Pl. IX.) from a beautifully accurate drawing by Mr. S. J. Mackie, and displays a limpet shell (*Patella vulgata*) with two barnacles (*Balanus balanoides*), in the position in which they adhered to the rock at the time when the back of the vein was washed by the waves; the lower part of the specimen—a piece of confusedly crystallized carbonate of lime, in fact, an ordinary veinstone—is spotted with little masses of galena, one or two of the crystals of which may be seen in the cut. It would be leading from the purpose of this paper to do more than remark that this species of mollusck (*Patella vulgata*) as well as the cirripedes (*Balani*), are animals inhabiting the tidal zone, and that, therefore, the limestone-ridge from which the specimen came must have fringed the shore, as does the same rock now near Newton, where the "backs" of lead-veins may also be seen at ebb-tide, encrusted with the same description of shells. By reference to any good geological map of the district, it will be seen that the point marked Llantrissant Lead-works lies apparently on the conglomerate, but the veins which are close by are found really in the limestone which has been exposed by the denudation of the thin cap of conglomerate. It follows from this fact, that, on the evidence of the shells, the mass of land lying to the south, and occupied chiefly by lias, was probably submerged until a very recent period, and that much of the present disposition of the gravel-beds, as already remarked, was given to them during the final elevation of the land.

But if thus much of elevation and denudation of the land has occurred, it is obvious that we must find evidence of great dislocation of strata,—of beds not only bent into simple or double curves, but of rents and fissures such as a succession of elevations and depressions, with their concomitant disturbances, would be sure to effect. And, accordingly, we find great lines of fault on the south-western seaboard, and inland to the edge of the coal-basin in Glamorganshire, running N.W. and S.W., and producing two principal systems of fissures, which intersect at nearly right angles. The effect of the N.W. fractures has been, mainly, to thrust up the strata into dome-shaped protrusions; and it is probable that these disturbances were of more ancient date than those which produced the undulating character of country, and which forced up the rocks in east and west directions, originating at the same time a parallel system of faults. It is in connexion with this series of east and west fissures that we must look for the origin of the deposits of hæmatite at Llantrissant and Newton Nottage.

The most important workings of the hæmatite-ore in the Llantrissant district, are probably those of Mr. Vaughan, at Cornel Park, and the adjoining Hendy Mine, on the lands of the Marquis of Bute. Both mines are worked "open-cast"—that is to say, the superincumbent strata are stripped from the upper surface of the vein, which is then worked through its whole thickness after the manner of a quarry. This is probably the most ancient mode of mining, and in countries where the "old men" have been, the magnitude of the excavations often affords a rude proof of the former wealth of the neighbourhood, as well as indicates the value of the deposits likely to be encountered by continued exploring. But to the geologist these open-cast workings possess the greatest advantages, since they reveal those details of structure and association, both in regard to the deposits themselves as well as to the containing rock, to an extent, and with an amount of convenience to the observer, which can seldom or never happen in subterranean mines. In both geologist and miner the workings in the vein of ore at Cornel Park must provoke a sense of wonder. Indeed they cannot fail to set the former speculating upon the origin and segregation of such enormous quantities of a particular mineral, which, by its mass and constancy of position, here becomes, stratigraphically speaking, almost entitled to the dignity of being considered a "formation," more especially if this word be considered equivalent to "period." The surprise, too, of the intelligent miner, in connexion with the experience of his profession, must be very great, since, in this case, we have the rare occurrence of a bed of ore "in sight," from which we can calculate the yield for a definite period, with almost grave certainty, without taking into consideration those chances and contingencies which render mines — under the best of circumstances—*par excellence* speculations.

A face of vein upwards of two hundred yards in length has been more or less laid open by Mr. Vaughan's excavation, and the average width of the "raising floor" is about thirty-five yards. A reference to the woodcut (Pl. X.) will afford the best idea of the dimensions and other details connected with the works. To obtain a weekly yield of 1,500 tons is said to be a matter of easy performance.

The mines at Cornel Park are situate about a mile and a half north of the Llantrissant Station on the South Wales Railway; and so far as regards the character of the limestone-strata, as seen in quarries and sections by and near to the roadside, but few indications are to be found of the vast deposits of mineral which exist in the vicinage. The stranger, accustomed to the position of mines, will probably look for operations at the foot of some hill, but the hills which are seen in the distance in travelling towards these works, are those of the coal-grits, and we unexpectedly advance upon the mines in a slightly undulating plane. The accompanying lignograph (Pl. X.), from a rough sketch I made on the spot, gives a representation of Mr. Vaughan's mine. On the left hand in the cut we have a section of the rocks on the dip of the beds, which amounts, on an average, to twenty-three inches in the yard. On the "face" we have an end section of the same beds, showing the thickness of the hæmatite-vein, the overlying conglomerate, and the great thickness—upwards of fifteen feet—and bedded character of the "drift." The magnesian conglomerate, from the sub-angular character of some of the fragments of limestone and sandstone of which it is principally composed, might perhaps be more properly called a breccia. The cementing paste is not of uniform composition, but is as often wholly calcareous as it is magnesian, and near the hæmatite it is usually highly charged with peroxide of iron. The "conglomerate" itself does not appear to include any fragments of solid ore. The nature of the cementing matter confers, especially at a distance, a more homogeneous appearance to the rock, and a rude description of bedding is always to be observed; the stratified character being further maintained by a series of horizontal "joints," along the lines of which the amount of weathering seems to have been greatest, and the *dolomitic* character most brought out.

The vein of hæmatite, it will be observed, reposes immediately on the uppermost bed of limestone, and is overlaid directly by the conglomerate; indeed, the one seems to form a bed separating the two descriptions of rock, and it might doubtless be assumed to be an interstratified deposit but for the great irregularity of the bounding walls. Moreover, interspersed in the mass, sometimes in contact with, but more often perfectly isolated from, the parent rock, large fragments of limestone lie bedded in the ore; while large cracks and fissures in the conglomerate, partly filled with ironstone, evidently prove that the two formations were first torn asunder, and the ore subsequently introduced. The ore differs mineralogically from the "mine" raised from the carboniferous limestone in other localities chiefly by a superabundance of silica, the associated minerals—veinstones—being chiefly quartz, large crystals of which may be found lining the angles and cavities in the vein. The magnitude of the deposit generally has already been referred to, but not its average thickness, which, from wall to wall, may be fairly calculated as not less than fifteen feet, and is probably much more as it lies deeper from the crop: the engine-shaft (see Pl. X.) passes through a mass of ore upwards of fourteen yards solid; but this, although taken perpendicularly, is of course an oblique measurement as regards the proper section of the vein. The siliceous character of the matrix has probably influenced the crystallization of the hæmatite, and the highest percentages are obtained from that description of ore known in the Forest of Dean as "flint-brush:" this ore presents a smooth conchoidal fracture, and much resembles in colour and surface the appearance presented by a freshly broken piece of cast iron. Another kind has a more granular fracture, possesses a colour between iron-grey and brownish red, has a semi-metallic lustre, and is of an exceedingly compact texture. A third variety might probably be called Black Hæmatite, and, from its affording a violet-coloured glass with borax before the blow-pipe, proves itself to be a mixture of iron-ore and manganese:—its colour is bluish black, and its lustre imperfectly metallic. All kinds are mostly impregnated and interlaminated with quartz, which frequently confers a fibrous or semi-ligneous character to the large masses, rendering them at the same time exceedingly hard to blast; the "getting of the ore" being almost exclusively performed with gunpowder. In the small cavities or angles, where we might expect to find the botryoidal forms or "kidney-ore," none such occurs, but instead, as mentioned above, we have often magnificent specimens of rock-crystal, inclosing minute but very perfectly formed crystals of specular ore. The "raddle" or fine powdery micaceous ore, which soils the fingers on the most delicate touch, and which is always distinctive of the Ulverstone hæmatite, and some of the ores raised in North Wales, is uniformly absent, and in lieu of it the less coherent parts of the vein-stuff are represented by an ochraceous earth (argillaceous hydrous sesqui-oxide of iron), which in wet weather works up to a stiff red mud, but is far inferior in per-centage of iron to the Ulverstone "raddle," (anhydrous sesqui-oxide of iron), which, like the "smith-ore" of the Forest of Dean, is always of equal value with the more solid products of the veins.

One of the most interesting lithological features connected with these Llantrissant mines is the "yellow clay" (ochre). This mineral occurs in great abundance, "riding" the vein near the crop above the deposit, and is several yards in thickness: it is of a pale lemon-chrome colour, and I have little doubt might find use as a coarse pigment. It is probably a hydrate of alumina and silica, with hydrate of the sesqui-oxide of iron, and, mineralogically, the equivalent of "Limonite." In my paper upon the Ironstone Formation of the Forest of Dean* I have mentioned the circumstance that the upper portion of the "joints" which cut across the underlying limestone of the "mine-measures" is filled with a highly ferruginous marl, described as "clod-ore;" and I may here observe, that ochraceous earths are superficially common to most of the deposits of ironstone in the carboniferous limestone. The origin of these ferruginous clays or marls must doubtless be assigned to the introduction of the wasted alluvial matters derived from the weathering of the contiguous rocks, and their subsequent amalgamation with the ferriferous matters of the vein, but it is at least curious, that each dissimilar deposit of hæmatite has its own peculiar character of "clod" in the same way that the veins of other minerals have their distinctive "gozzans" and *surface* associations of particular minerals. This "clod" may either be a ferruginous clay or a ferruginous marl, according as the gangue of the ore is siliceous or calcareous. In the Llantrissant district, the matter being chiefly silica, we have the "clod" in the form of a yellow clay (the "native ochre" of the painter), but nevertheless containing lime: in the Forest of Dean the ores are calcareous, and the "clod" is a true marl, highly charged with small fragments of compact hæmatite, or "black brush."

---

* GEOLOGIST, vol. i. p. 270. 1858.

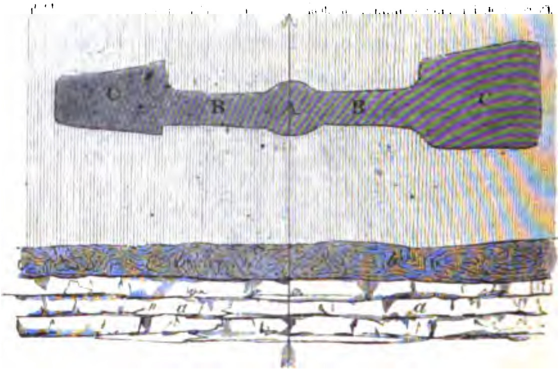
The exact geographical range of the ironstone-deposits contiguous to the boundary of the coal-measures, has not yet been ascertained — although there has as yet been no lack of enterprise to make discoveries. In the Llanharry district, which immediately adjoins Llantrissant, a score and more of trial pits testify the eagerness of the search; and wherever this has been rewarded, the ore has been found similarly situated with respect to geological position, that is, near the axis of some anticlinal of the limestone.

The common mining-axiom, that the depth from surface and *wealth* of a vein are conterminous facts, is certainly not founded on any precedent derived from the occurrence of those deposits of hæmatite-ore which lie (as it were) *bedded*. Indeed, unlike copper or tin, or even lead, of which, as a vein or lode "holds down" in depth, *it* assumes a richer mineralisation and more constant ore-bearing character, iron-ore *in veins* is not generally found in deposits of the same magnitude in depth as near the surface; and more especially when the run of the veins is horizontal. In the Forest of Dean, where this horizontal or "bedded" character of the deposits is almost typical, it is extremely doubtful that, if the centre of the basin were proved by deep "winnings," the ore would be found in the same quantity as near the basset of the "measures;" and, taking the same view, I believe that any sinkings through the dolomite to the synclinal troughs of the limestone at Llantrissant and Llanharry would be, both geologically and economically, failures. But it must be understood that by deep "winnings" I do not mean the actual depth at which a shaft may intersect a vein of the ore, since, although actually very near to the crop, certain deposits may be carried deep from surface by the high angle at which the strata may be raised. My restriction of the unproductive region relates only to the troughs or positions near to the synclinal axes, and to which the exoteric agents, which aided mainly in the deposition of the ironstone, could never possibly have penetrated.

On the statement of this fact, that these veins of hæmatite may be considered superficial, the question of origin next arises. And here is immediately opened to us the wide inquiry of the relationship of mineral veins to the rocks which inclose them. With veins filled with other ores than those of iron, the origin of the metallic accumulations may, in most cases, be referred to causes acting from distant centres in the interior, assisted by those subterranean changes which are the universal result of the calorific and electrical agents that are always at work in the earth's crust.

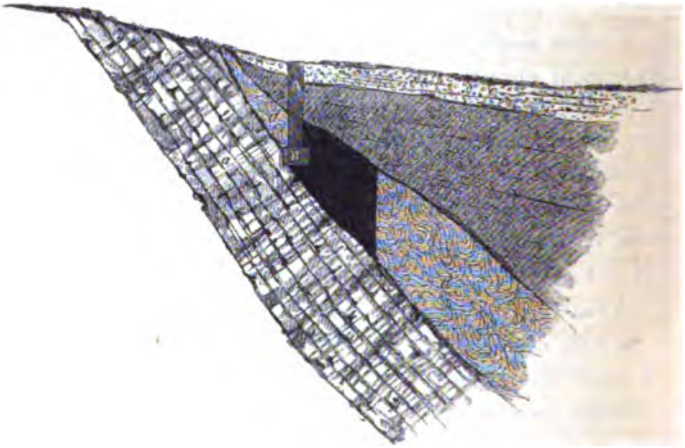
In a few words, the origin of these veins may be considered esoteric, or produced from within. With iron, however, in nearly all cases, an external derivation must be sought. The great solubility of its salts and chemical combinations, their affinity, and the proneness of the metal itself to enter into union with substances with which it may have newly come in contact, gives to iron in its various forms a more world-wide distribution than is perhaps possessed by any other metallic mineral. Its local accumulation will therefore probably be the result of its chemical segregation and the nature of its combinations; in other words, the particular class of ore will be governed by the mineral character of the transported matter, those portions which do not separate as ore solidifying into the vein-stones, or "gangue," which may either be amorphous or crystallized, according to circumstances.

In the Llanharry district there is a bed of hæmatite five feet in thickness, of the same mineralogical character as the Llantrissant deposit, and occupying a similar geological position in the limestone. This bed has been anciently worked to some extent at Lleche, and, from the form of the chambers, or "stalls," and the narrow pit by which access was gained to the vein, probably by the Romans, who certainly were acquainted with the existence of the ore in the district. Some coarse red pottery, of undoubted Roman manufacture, was found a few years since buried in a small pit made in the bottom of an ancient stall-working at Ty-Ischaf. The pottery, which consisted of small amphoræ, was accompanied by some bones but unfortunately both were scattered by the finders. The age of some of the workings, however, is probably more recent than the time of the Romans; and in the Ebbw Vale Museum the skeleton of a miner, and an oaken shovel, can be seen, which were exhumed together from an old working. The character of these ancient excavations is shown in the subjoined plan and section, which exhibits a



Lign. 2.—Plan of Ancient Mine Workings in Vein of Hæmatite Iron Ore, Llanharry.

a a. Outcrop of Carboniferous Limestone.
b b. Hæmatite Vein.
A. Pit.
B B. Headings.
C. Stalls.
The arrow shows the direction of the dip.



Lign. 3.—Section of Ancient Mine Workings in Vein of Hæmatite Iron Ore, Llanharry.

a. Carboniferous Limestone.
b. Conglomerate.
c. Superficial Drift.
d. Vein of Hæmatite.
A. Section of Shaft.
B. Section of Heading.
C. Section of Stall.

working on the vein. The pits were usually sunk down some twenty-ive yards on the "dip," and low headings were then driven out on he "course" or "strike" of the vein, the headings terminating in "stalls," which are "chambers" turned at right angles to the "pitching" of the deposit which it follows down. The diagram, however, will afford a clearer idea of this plan of working than any written description. It is difficult to assign any reason for the small size of the pits and the lowness of the "headings," seeing that such arrangements must have offered great impediments to the bringing out of the ore from the mine, unless it were that the rude nature of the tools, and slow progress thereby caused in working through the rock, rendered it more economical to confine all the means of access to the smallest possible dimensions.

In the commencement of this article I have referred to the rediscovery of these iron-ore deposits, since, apart from the evidence of the ancient workings, Leland in his "Itinerary" says, "There are two faire parkes by south of Llantrissant now unimpalid and without deere. There is yren now made in one of these parkes, named 'Glinog.'" The mine at Cornel Park, worked by Mr. Vaughan, is probably the mine referred to by Leland. The proof of the former mining-associations of the locality extends also to the names of places. Thus, near Mr. Vaughan's mine is Mwyndy, or the Miner's House; and at Lleche, near Llanharry, is a building called Castell y Mwynwrs, or the Miner's Castle, and is situate near, I believe, the largest deposit proved by Mr. Plant in the Llanharry district.

The deposit at Newton, as I have already stated, is remarkable for having, intercalated with the hæmatite, a bed of manganese-ore, or black hæmatite. The vein was first discovered at Guar Coch, where it has been worked to a limited extent, and where the diagrammatic section delineated in Plate XI. can now be seen.

We have presented there:—

(*c*). Gravel	——.
(*b*). Conglomerate . . .	6 feet.*
(*d*). Hæmatite	1 foot.
(*e*). Manganese	4 feet.
(*d*). Hæmatite	3 feet.
(*a*). Limestone	——.

---

* The section is purposely exaggerated to better show the details—the real thickness of the several beds is mentioned in the text.

The manganese-ore is singularly free from iron, and its position between the beds of hæmatite forms altogether a most remarkable association of minerals. The character of the veinstone of the hæmatite at Newton differs from that at Llantrissant by the absence of silica and its replacement by calcareous minerals. Small leaders of ore, called "blowers," run up into the magnesian conglomerate at right angles to the general mass, and are analogous to the "joints" which intersect the "mine-measures" in the Forest of Dean. The ore dips fast to the south at the crop, but would seem to "flat" as it passes towards the centre of the basin. Near Pyle, traces of the hæmatite are to be seen at low-water occupying the flank of the limestone basin immediately under the magnesian conglomerate; and both there and at Newton the deposits course in an east and west direction. Besides the psilomelane, which forms the chief bulk of the ore, there is a small admixture of pyroluaite, but the vein may be considered "massive grey manganese," such as occurs at Upton Pyne and Dodscomb Leigh, in Devonshire.

In the Newton District the ploughshare has brought up the evidence of former workings of the ore, as near Llantrissant, and iron-cinders, old slags, and even pieces of ore, are to be found scattered over the fields. The borough of Kenfig, in this district, consists of a solitary house; and this fact is significant of the place having once been of importance, arising, no doubt, from the metallurgical operations formerly carried on by the Romans, or some other people, in the neighbourhood,—the ancient town having disappeared with the removal of that industry which had created the settlement.

Antiquarian matters do not properly fall within the province of this article, but those of my readers who have curiosity in these matters had better repair to the *locus in quo*, where they may find an abundance of material:—the geologist will have an opportunity of examining there some of, perhaps, the most wonderful phenomena in connexion with the petrology of the British Isles.

FOREIGN CORRESPONDENCE.

By Dr. T. L. Phipson, of Paris.

History of a large and recent Aërolite—Its Mineralogical Composition—Vibrations of the Earth—A new Mineral, Vitriolite—The Metal Tungsten.

Much attention has been excited in France for some few months past by the fall of a large aërolite, which took place in the canton of Montrejeau on the 9th of December last. We have now all the details that we are ever likely to have concerning this remarkable meteor. It fell about seven o'clock in the morning, appearing first in the north-east like a large red-hot bomb, which passed rapidly to the south-west, where it remained stationary for an instant. It then emitted a considerable column of smoke and flame; three seconds after which a loud detonation was heard, followed by a rumbling noise. Although in broad daylight, the little town of Aurignac was completely illuminated by the passage of this aërolite. After the explosion nothing was observed in the sky but a streak of vapour and a small cloud which marked out the direction followed by the meteoric stone, and the place where it exploded. Shortly after this phenomenon two large fragments of the aërolite were picked up in the parishes of Aussan and Clarac; one of these weighed about 90 lbs., and had sunk into the ground for nearly two yards; the other, that fell at Clarac, broke through the roof of a cottage; it weighed from 16 to 20 lbs., and was so hot when first seen that it could not be touched for some time. These blocks present rounded forms, their surface is black and smooth, the interior is formed of a sort of grey substance, not unlike certain volcanic products in structure.

We enter into these details for two reasons: first, they are authentic; and secondly, they represent the history of almost every aërolite that has been thoroughly observed. The aërolite of which we speak is not uneasily broken into fragments. According to MM. Filhol and Leymerie, who have examined it, its specific gravity is 3.30; and it presents in its granular structure numerous small and brilliant laminæ of a metallic lustre. The stone attracts the magnet, but has no poles. Before the blow-pipe it becomes black, and emits a sulphurous odour, but does not melt. To fuse it completely, it was found necessary to employ the oxy-hydrogen blow-pipe; the result was a black globule, not unlike the crust or rind of the aërolite itself. MM. Filhol and Leymerie have analysed this stone; but their analysis is not good. We are indebted to MM. Chancel and Moitessier, of Montpellier, for a knowledge of its exact composition. They affirm that the aërolite of Montrejeau resembles, in a chemical and mineralogical point of view, those of Chantonay and Chateau-Renard, of which we have spoken in a preceding number of The Geologist (vol. ii. p. 85). A first analysis gave them "10 per cent. of magnetic substances (iron and iron-oxide); 1.70 of chrome-iron, 5.70 of protosulphuret of iron, 48 per cent. of silicates soluble in acids, and consisting principally of peridote; 17 per cent. of silicates insoluble in acids, and consisting principally of feldspar and amphibolite." They then proceeded to analyse, with more care, that part of the aërolite which is insoluble in nitric and hydrochloric acids; and the result is as follows:—

Silica	56.613
Alumina	6.653
Magnesia	19.447
Lime	4.012
Protoxide of iron	9.212
Oxides of nickel and manganese	1.100
Soda	2.128
Potash	0.398
	99.563

Berzelius, Rammelsberg, and other chemists who have occupied themselves with this sort of analysis, have already remarked that the composition of the silicates which are insoluble in acids does not coincide with that of any one known mineral. Thus, from the above analysis, it is impossible to write down any chemical formula, as the oxygen of the silica is not proportionate with that of the different bases. This circumstance shows that the insoluble residue is not composed of one silicate only, but of a mixture. Rammelsberg has shown that the simultaneous existence of alumina and alcalies in such a case indicates the presence of feldspathic minerals. He found, as we have before noticed, that in some meteorites this residue coincided exactly with the composition of hornblende or augite, according as the alcalies were attributed to labradorite or to oligoclase. It is impossible, in the absence of distinctive crystalline forms, to prefer one of these hypotheses to the other; each is equally good.

Following M. Rammelsberg's method, MM. Chancel and Montessier conclude that the *soluble* portion of the silicates in the aërolite of Montrejeau represents labradorite, and the *insoluble* portion hornblende; or, if the soluble part be made to represent oligoclase, the insoluble portion becomes augite. Hence the mineralogical composition of this remarkable aërolite may be thus represented:—

Magnetic portion (iron and oxide of iron)	10.04		
Chrome-iron	0.67		
Proto-sulphuret of iron	5.72		
Peridote	45.08		
Labradorite = 8.34		or,	10.99 = Oligoclase
Hornblende = 29.17			26.59 = Augite.
	99.02		

There is a slight error in the figures on the right, representing ligoclase and augite.

During our visit to England, in the autumn of last year, M. Prost published the following note (which has escaped our attention until now) upon certain vibrations of the earth observed at Nice during the winter of 1857-1858, and since that period:—"When I came back to Nice in October, 1857, my pendulum remained perfectly quiet for about twenty days; but it began to move suddenly on the 4th Nov., and oscillated with considerable intensity. The movement was accompanied, as usual, by that of the glass hangers of the chandeliers. These oscillations, after having diminished gradually for some days, showed a new activity about the 18th, which lasted till the 22d. I have been able to ascertain that the date of the 4th November corresponds to that of the violent earthquake which took place at Meneggio on the Lake of Como, and the other dates with shocks observed on the 19th at Pontévédra and at Lisbon, and on the 21st at Lisbon and Porto. Since then the oscillations of my pendulum have been almost permanent, presenting very rare intervals of repose; and their intensity augmented again on the 15th December, and lasted for a very long time; the glass hangers oscillated without interruption up to the first days of January, 1858. It was during this period that the earthquake at St. Denis-du-Sig, in the province of Oran, took place, on the 14th December; then the terrible shocks felt at Naples and in La Pouille on the night of the 16th and 17th December, which, after having been felt on the 17th at Hernosand, in Sweden, on the 20th at Agram, in Croatia, continued for a long time, and occasioned many disasters in those countries. Again, on the 25th, shocks were felt at St. Veit, in Austria, and at Admont and Rosegy in the valley of Eros. Their sphere of activity spread itself, therefore, to a great distance, for during the same period, *i. e.* from the 20th December, shocks of earthquake happened in succession at Brousse, up to about the 15th of January, and on that day were felt at Ratibor, in Silesia, whilst on the 11th an earthquake took place at Martinique, and on the 26th there was one at Parma."

About the end of February, 1858, the oscillations of M. Prost's pendulum began to diminish gradually; in the months of May and June there were very few. But they began again in July, and continued with increasing intensity until the night of the 4th and 5th August, when a shock took place about half-past two A.M., which awoke the inhabitants of Nice out of their sleep. "It is, therefore, certain," says M. Prost, in conclusion, "that this phenomenon of oscillation, which had never yet been observed, is in connexion with earthquakes; but that it differs from the latter inasmuch as, instead of being sudden and violent, like a shock, it manifests itself as a vibration, the duration of which may be hours, weeks, or even whole months."

Our accomplished friend, M. Pisani, has lately received from Constantinople samples of a new mineral found in the interior of Turkey, and which presents a rather remarkable composition. It is seen to form large stalactites in caverns near a mine of copper-pyrites; its colour is that of sulphate of copper, in the parts freshly broken (but with a green ochraceous tint on the exterior), whilst its crystalline form is that of sulphate of iron. On analysis, it turns out to be sulphate of protoxide of iron, in which part of the oxide of iron is replaced by a corresponding quantity of oxide of copper. The figures obtained in M. Pisani's analysis are as follows:—

		Oxygen.	Proportion.
Oxide of copper	15.56	3.14	1
Protoxide of iron	10.98	2.44	
Sulphuric acid	29.90	17.94	3
Water	43.56	38.72	7
	100.00		

This composition leads to the formula :— $\left.\begin{matrix}\text{Fe}\\ \text{Cu}\end{matrix}\right\}\text{O, SO}^3 + 7\ \text{HO}$.

We have also analysed this new mineral, and our figures coincide very closely with those above.* The formula arrived at is that of common green vitriol in which a certain quantity of iron is replaced by copper, the crystalline form having remained intact. It is *probable* that the natural production in question has been formed in the waters that filter through the beds of copper-pyrites, and that it could be formed artificially in the laboratory.

Tungsten is a metal which has been hitherto little studied in a practical point of view. It appears destined, however, to operate a complete revolution in the manufacture of steel. It has been lately affirmed that an alloy formed of 80 per cent. of steel and 20 per cent. of tungsten, possesses a degree of hardness that has never yet been obtained in the manufacture of steel. This alloy works upon the latter, and can even cut it. Experiments have been made with this new composition at Vienna, Dresden, and at Neustadt-Ebertswalde, and considerable quantities of the alloy are being manufactured, *it is said*, in that part of the world. Many old tin-mines have been bought up with a view of extracting tungsten-ore, and considerable sums have been given for mines that had ceased to be worked long ago.

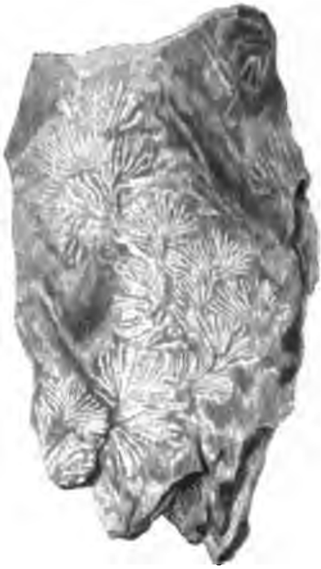
---

* Another sample of the same substance analysed by ourselves gave the following result:—

		Oxygen.	Proportion.
Oxide of copper	15.86	3.17	1
Protoxide of iron	11.00	2.44	
Sulphuric acid	28.08	16.85	3
Water	45.06	40.05	7
	100.00		

Formula :—$(\text{Fe}\,{}^{\cdot}\text{Cu})\,\dddot{\text{S}} + 7\ \dot{\text{H}}$.

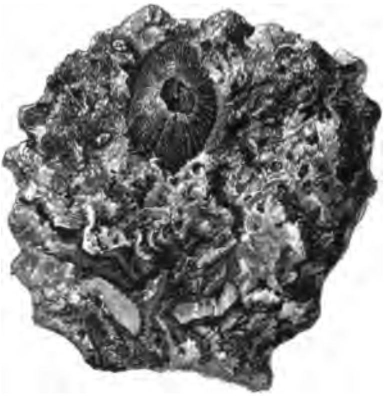
In the result given in the text there is evidently a slight excess of acid in proportion to the quantity of oxide found. We have proposed for this mineral the name of *Vitriolite*.—T. L. P.



OLDHAMIA ANTIQUA.—From Bray Head

In the GEOLOGICAL SURVEY MUSEUM, Jermyn Street

S. J. MACKIE del.



PATELLA VULGARIS and BALANI, on a Fragment of the Outcrop of a Lead Vein from Llantrissant

In the Collection of Dr Watson

S. J. Mackie del.

THE GEOLOGIST.

JULY, 1859.

ON THE RED CHALK OF ENGLAND.

Read before the Geologists' Association, 4th April, by Rev. THOMAS WILTSHIRE, M.A., F.G.S., Etc., President.

PERSONS in general take as the type or representative of chalk the material which mechanics employ for tracing out rough lines and figures. It is a substance of a bright white colour, somewhat yielding to the touch, and capable of being very easily abraded or rubbed down.

But the geologist gives a much wider interpretation to the term, not limiting it by these few characteristics; and, accordingly, he includes under the same title many strata which would hardly be so grouped together by the uninitiated.

For instance, there is at the base of the upper portion of the cretaceous system a certain hard, often pebbly, and highly coloured band, which, notwithstanding its great departure from the popular type, is nevertheless styled in geological language the "Red Chalk." This stratum, the subject of the present paper, nowhere forms a mass of any great thickness or extent; perhaps if thirty feet be taken as its maximum of thickness, four feet as its minimum, and one hundred miles as its utmost extent in length, the truth will be arrived at. It may be said, also, to be peculiar to England, for the *Scaglia*, or Red Chalk of the Italians, has little in common with that of our country. The two differ widely in appearance, in situation, and in fossils.

The first view of the seam in the north is to be obtained about six miles north-west of Flamborough Head, in Yorkshire, near the village of Speeton, where its structure, dip, and general appearance can be remarkably well studied.

Speeton is a small village, a place of no great note in the business world, yet of much fame amongst the lovers of geology, inasmuch as in its neighbourhood there are several interesting formations, to one of which—the Speeton clay—it gives a name.

In these days of rapid travelling, the village has the great convenience of a railway-station, from whence the cliffs below can be reached without the slightest difficulty.

As I wish to conduct the members of the Association to the Red Chalk *in situ*, let us suppose that, starting from some locality near the Hull and Scarborough Railway, we have taken tickets for Speeton

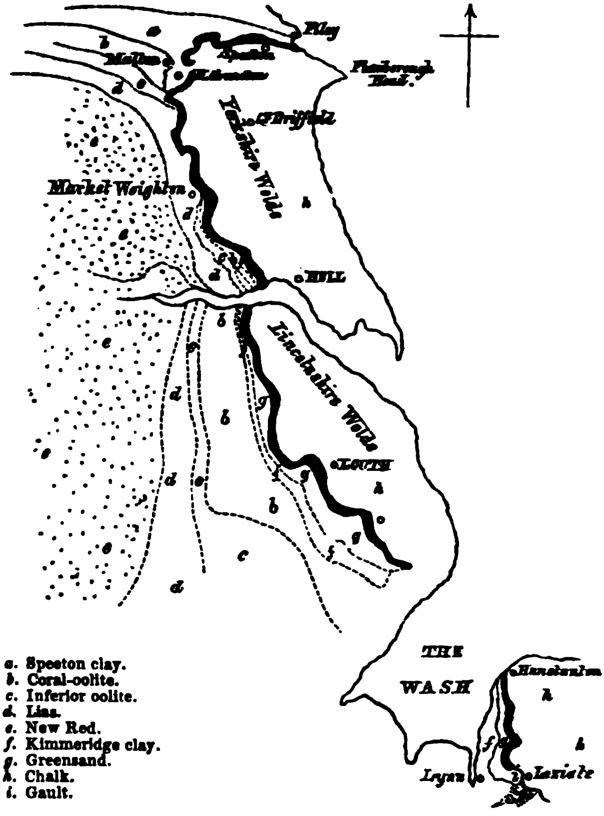


Fig. 1.—Map of Part of Yorkshire, Lincolnshire, and Norfolk, showing the Outcrop and Range of the Red Chalk.

ation, and have in due time arrived at that latter place. On alight-g from the train we must direct our steps to the houses in front, nd then inquire the way to the sea-shore, above which we shall be tanding at some considerable height—say four hundred feet. We hall be told to walk by the church, to turn to the right along a ittle lane, and then to look for an obscure path which passes across he fields. We shall soon afterwards, being on high ground, be able, y the light of nature, to find a way down to the sands below.

Whilst descending, let us survey the scene that lies before us. It s a grand one, rendered picturesque by the broken ground, the solitude, and the sounding of the waves. Right ahead, there is the open Bay of Filey; on the left hand, the town of Filey and its Brig; not a ship, as one might imagine, but a huge mass of rocks of the coralline oolite, jutting out to sea at right angles from the shore, like a pier formed by human hands, and crowned on the land-side by strangely cut pinnacles of pink and rugged drift. On the right hand there are the high and perpendicular white chalk cliffs of the Flamborough range. As we pass down we shall meet with a gulley or bed of a small stream, in all probability quite dry, by following the winding course of which we shall reach the shore. This gulley passes over an escarpment of diluvial matter (the whole place being in confusion through the effects of small landslips), and traverses the Red Chalk itself, the first trace of which will be rendered visible by means of rolled fragments, which the force of the stream has at different times detached.

It will be only here and there that we shall find the Red Chalk *in situ*, because sometimes vegetation, sometimes diluvium, sometimes fallen masses, entirely conceal its real position. However, there will be plenty of rounded pieces at the feet. Some of these had better be examined on the spot, in order that we may gain a clear perception of the appearance of the bed, should we meet with it again. These pieces are found to be hard and rough to the touch, and of a bright red tinge, though occasionally marked with streaks of white. Most likely on some of their sides a fossil or two will be seen peeping out; a blow from a hammer will divulge still more. So plentiful are the rolled fragments, that a few hours' work will satisfy the conscience, and fill the pockets of the traveller.

If I might be permitted to give advice to any member of our Association who should hereafter visit the place, it would be this—that it would be well for him to carry away moderate sized boulders entire, rather than to break them on the spot. The fossils will best be developed at leisure. The material is so hard, and the fossils so brittle (especially the belemnites and serpulæ), that imperfect specimens only will result from the quick and rough treatment of the hammer. The "find" will not produce any very great variety, only numbers; terebratulæ, serpulæ, and belemnites will be all that will be obtained.

Having now procured specimens, we had better walk southward along the shore; after a short time will be seen a fine perpendicular section of this particular stratum; we shall notice it is bounded on the one side by the White Chalk, to which it is parallel; on the other by the Speeton clay, which is not conformable to it, that is, not parallel.

The thickness of the bed of the Red Chalk is at this place, as I said just now, about thirty feet. First of all, taking it in descending order, that is to say, having reached its limit at the White Chalk, and retracing our steps in the direction of Filey, we notice about twelve feet of red matter containing serpulæ, and we note that the upper portion of this division is much filled with greyish nodules, showing that the change from the White Chalk to the Red is gradual. Next comes a bed of about seven feet thick, of darkish White Chalk; and finally, another bed of about twelve feet thick, of bright Red Chalk, containing belemnites and terebratulæ. The whole is followed by the Speeton clay, of which a short and accurate account will be found in No. 13 of THE GEOLOGIST magazine. The line of division between these two being well marked by runs of water, which are caused by the percolation through the chalk being stopped by the impervious clay.

The Speeton clay is singular in some of its characteristics. At its upper portion, in contact with the Red Chalk, it contains fossils belonging to the Neocomian or Greensand era, whilst at the lower part there are the representatives of the Kimmeridge clay. And thus it would appear to be one of those peculiar formations which have resulted from a number of beds thinning out, and becoming absorbed into each other. Three of the well-marked fossils of the Speeton clay may be adduced: *Belemnites jaculum*; a small crustacean, *Astacus ornatus*; and a large hamite, called *Hamites Beanii.*

To the south of the Red Chalk at Speeton, and adjoining it, occurs, as I lately mentioned, the White Chalk. The fossils in this part are not numerous; an inoceramus, a terebratula, and rarely an ammonite, are found. But the White Chalk higher up, that is, farther south, below Flamborough Head, near Bridlington Quay, is very fossiliferous, containing corals, echini, a bed of marsupites, as well as that very remarkable and extensive collection of marine forms, the silicified sponges, thousands of which can be seen at low water scattered up and down, and imbedded in the scars, or rocks. This chalk, however, has its drawbacks, for being very hard—indeed, so much so as to ring under the strokes of a hammer—specimens cannot be obtained without much trouble. I must make an exception with regard to the sponges. They are composed of silex; hence, long soaking in very dilute hydrochloric acid will do more and better work after the fossils have been brought home, than fifty chisels. The calcareous matter is slowly dissolved away, and then forms come into view as delicate and lovely as any that can be noted in the modern sponge tribe. Most of the common kinds of the Flamborough sponges will be found figured and named in Professor Phillips' Geology of Yorkshire; the rarer in the Magazine of Natural History for 1839.

Let us now return to the village of Speeton, and endeavour to follow the winding course of the Red Chalk to its visible termination, some hundred miles to the south-east, in the county of Norfolk.

By a reference to the map (page 262), where the bed is laid down, it is seen that the Red Chalk adjoins the White Chalk during its entire length; that it first takes a westerly direction for about twenty miles, and then suddenly turning at a sharp angle proceeds south-east for the remainder of its course.

Some persons might suppose when they see the map, that if they were to travel to any of the towns or villages near the line, they would of necessity be able to see the Red Chalk *in situ.* No such thing; the upper soil, or vegetation, or man's work, may quite conceal all traces. It is only at natural sections like the cliffs just spoken of, or by other means, such as wells, &c., that we can acquire a true idea of the ground beneath us. Who, for example, that lives in the City of London, could imagine, unless he had seen the fact for himself, when sewers were opened, or foundations cut, that he was dwelling over beds of gravel as bright and yellow as any that cover the paths of a flower-garden?

When, therefore, the nature of the surface of the ground is such that the eyes cannot detect traces of any particular formation we may be in search of, we must seek other testimony, we must ask what have other men seen, and what have they recorded, and in whose custody have they placed the keeping of those facts.

In the present case I can refer to two excellent works, to help us,—Professor Phillips' Geology of Yorkshire, and Young and Bird's Survey of the Yorkshire Coast.

Let us turn to the latter. The authors write that in the year 1819 a Mr. George Rivis, of Sherburn, bored for coal in a deep dale about a mile and a half south of Staxton; the boring was continued for some considerable depth. First they passed through the White Chalk, next came upon the Red seam, and finally, at the depth of 288 feet from the mouth of the bore, reached the Speeton clay. Thus then near Staxton, a few miles west of Speeton, the Red Chalk exists; there it is, though it may not be visible.

If we proceed still farther west along the northern foot of the Yorkshire Wolds, it is possible that at Knapton we shall actually see the Red and White Chalk again *in situ*; for Young and Bird tell us that, at a clay-pit near that village, it was to be seen in their day. At North Grimston, they add, the coloured chalk seems to be wanting, for at a copious spring issuing on the hill-side, about a mile above the village, the White Chalk is seen lying immediately over the blue clay.

This statement is not to be wondered at. Look at the map (page 262). Not far from North Grimston there must evidently be great unconformity of strata. Notice several of the formations, instead of running parallel to one another, actually are at right angles. For instance, we have the Speeton clay, the oolites, and the lias, almost perpendicular in direction to the White Chalk, a little to the west of Great Driffield. Such a condition of affairs must have resulted from great disturbances, and there would be nothing strange in a part of the series being displaced or altogether wanting.

Some miles to the south, near the town of Pocklington, the strata are again parallel in direction to each other, and accordingly the Red Chalk is found, as before, at the base of the Wolds. Professor Phillips, in his work on the Geology of Yorkshire, figures some Red Chalk fossils from Goodmanham, near Market Weighton, and alludes to their also occurring at Brantingham, not far from the River Humber, the boundary of the county.

Thus, then, the Red Chalk has been traced through Yorkshire; speaking roughly one might say, that it for the most part takes an undulating course at the base of the Wolds; that it rises with a very gentle inclination from the sea near the village of Speeton; that it proceeds nearly due west until it approaches the neighbourhood of Malton, that it then suddenly changes its direction, and advances south-east until it sinks below the marsh-land six or seven miles to the west of Hull, having occupied a distance of about fifty miles.

We now cross the river Humber, and find the Red Chalk again near the banks at a place called Ferraby, to the west of Barton in Lincolnshire.

The Museum of the Geological Society of London possesses specimens taken from that part, and in a note attached to them there is this remark, that first came White Chalk, then Red Chalk, then a blue clay; thus it is evident there is the same state of things prevailing as we had at Speeton; and the same observation will apply to the appearance of the specimens themselves.

But as we travel along the western base of the Lincolnshire Wolds, or Chalk Downs (for Londoners would so term them), although we find the Red Chalk underneath the White, yet the blue clay beneath the Red Chalk is wanting; its place is supplied by a thick series of brown coloured sands, with included beds of sandy limestone, full of fossils like the Kentish Rag, only not possessing echini and belemnites. These beds have been referred to the lower greensand.

Only a few remarks can be offered in reference to Lincolnshire. My intention was to have visited the base of the chalk-hills, and have gathered together new facts; I have not been able to do so; neither have I been successful in discovering any authors who have written much about that county. There is a great geological darkness over that land, and much remains to be done in working out its fossiliferous deposits. I can, however, speak confidently regarding Louth.

One might fancy, as the town is placed to the right of the dark line on the map, which marks the position of the Red Chalk, that Louth could have nothing to do with the latter. But a friend who made some inquiries for me on the spot has forwarded two specimens, and says he saw them taken out of a chalk-pit at that town. They ran in veins, he writes, the lighter coloured over the darker, and were dug at no great distance below the surface. The bright red piece was just above where the springs arise—facts which correspond with evidence in other places.

As the inclination of the plane of the strata is small, and rising towards the south-west (the direction of the strata being north-west), it is easily comprehended that the Red Chalk may exist under Louth, and yet not appear at the surface of the ground until at some distance to the west of the town.

At Brickhill, near Harrington, the seam also has been met with; a specimen of it can be seen in the Museum of the Geological Society of London. This last and those from Louth differ little in appearance or character from what may be obtained at the Speeton beds.

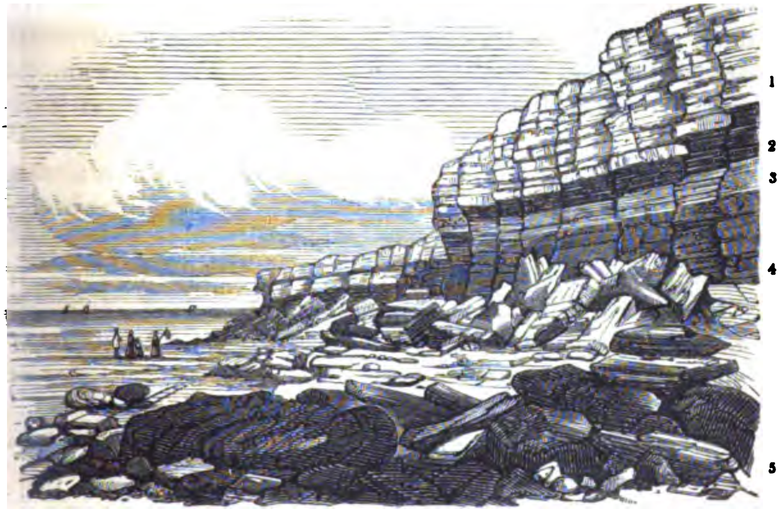
I have no more to say about Lincolnshire, except that, according to the authority of geological maps, the Red Chalk of that county sinks and disappears below the marsh-lands, a few miles before reaching the sea.

And now it is time to cross the Wash, that great sea-bay, and land at Hunstanton, a little village on the north-western coast of Norfolk. As I am addressing a company of working geologists, I ought perhaps to say how in practice the locality can be arrived at, for it is not quite so easy to reach a place in reality as it is to see it on a map.

To go to Hunstanton, in the most ready way, a person must first reach Lynn; whence an omnibus, starting in the afternoon, at three or four o'clock, from the Lynn station, will convey passengers to the village.

At Hunstanton there are two hotels, and several lodging-houses. I should recommend the Le Strange Arms, as being an old-fashioned comfortable inn, and nearer than the other to the section we are in quest of. Perhaps it may be thought, Why dwell so much upon Hunstanton—its hotel—and its omnibus? I do so because at that village there is a most excellent natural section of the Red Chalk, etter almost than at Speeton, and different certainly in many respects.

We will suppose that we have arrived at Hunstanton, and are walking towards the shore in front of the Le Strange Arms. A very few minutes will convey us to the wonderful cliff. I say wonderful, not from its height or length; for at its greatest height, under the lighthouse, it is not more than sixty feet; and it extends little more than a mile in length; but wonderful from its curious colour and general effect.



Lign. 2.—Hunstanton Cliff (looking to the North).

The woodcut, copied from a water-colour drawing, made last autumn by a friend, will afford an idea of its appearance; but in it the absence of colour, of course, takes away from the beauty of the scene.

The cliff itself may be divided into five portions: first, White Chalk, forty feet thick; secondly, bright Red Chalk, four feet; thirdly, a yellow sandy mass, ten feet; fourthly, a dark brown pebbly stratum, forty feet; and, lastly, twenty feet of a bed almost black.

These divisions do not run one into the other, as is the case in most geological strata, but keep quite distinct. Thus the Red Chalk is as clearly separated from the White, as though the one had been covered by a broad band of paint. The same observation will hold good with respect to the others.

It will readily be understood that when the sun shines upon the cliff, and lights up the bright white, the bright red, the pale yellow, and the dark brown and black, and casts a shadow over the mass of gaily tinted materials at the base, a picture is produced not easy to be surpassed in beauty, and certainly not to be fully appreciated unless it be actually seen.

The bed of White Chalk above the Red is, at Hunstanton, very fossiliferous; though rendered somewhat useless, like that of Yorkshire, to the geologist, from its extreme hardness. Amongst other shells, may be mentioned several kinds of serpulæ, belemnites, and ammonites. These last are occasionally very large: when I was at Hunstanton, in the autumn, I found an example two feet in diameter; with great difficulty I extricated it from its matrix, breaking it in half during the operation; and, finally, had the mortification of discovering that its weight was so great I could not carry it away.

The Red Chalk beneath, which is nearly four feet in thickness, is very full of fossils: belemnites, serpulæ, terebratulæ, corals, and many others, not to mention bones. The number of specimens on the table will testify to its richness in organic remains.

Sometimes it is soft and crumbling; but, generally speaking, it is very hard, gritty, of a bright red shade, and full of small dark-coloured siliceous pebbles; in this respect differing considerably from the Red Chalk of Speeton—in which I have not seen pebbles. Professor Tennant, who has examined the Hunstanton pebbles, informs me that they consist of *chalcedony*, *quartz*, *flint*, *slate*, and *brown spar* or *carbonate of iron*.

It also contains a great quantity of fragments of inocerami, and a curious ramifying sponge-like structure (there is one on the table), which also occurs in the White Chalk above.

Something very similar to the ramifying sponge is seen on the surface of blocks on the sea-shore at the back of the Isle of Wight in the greensand formation, and one very like it on the calcareous grit of the Yorkshire shore. You will observe these last to the north of Filey, but nothing of the same appearance exists in the White Chalk at Speeton.

Underneath the Red Chalk of Hunstanton occurs a yellow and rown pebbly sandstone, which was formerly supposed to contain no rganic remains. Mr. C. B. Rose of Yarmouth, however, has obtained many.

This bed is termed in those parts "carstone," and much employed as a building-material. The cottages in that neighbourhood and on the oad from Lynn seem at a distance as though they had been constructed of masses of gingerbread, so great is the similarity in colour and appearance.

The length of the Red Chalk, from end to end, at the Hunstanton Cliff is about 1,000 yards, and its greatest elevation at the point where it attains the top and quits the cliff is thirty-seven feet; hence its rise is very gradual, since its first appearance is nearly on a level with the beach.

There are two other things worth observing at Hunstanton. One is the lighthouse, which is upon the dioptric principle, the light being transmitted out to sea by means of glass prisms instead of the ordinary metal reflectors; and the other is a vestige of a raised sea-beach on the cliffs composed of rounded fragments of White and Red Chalk immediately reposing on the greensand. It is situated at the southward of the point where the Red Chalk crops out.

We will now, if you please, quit Hunstanton, and proceed towards Lynn, keeping in the neighbourhood of the coach-road.

If we could dig up the ground when we were within eight or nine miles of Lynn, we should still see our old companion at our feet, for the Red Chalk has been recognised at the villages of Ingoldsthorpe and Dersingham.

We shall soon meet it no more. At Leziate, a little to the north-east of Lynn, it becomes extinct. Mr. C. B. Rose, who always thought the Red Chalk would prove to be the equivalent of the gault, and who argued from the evidence of fossils and from the direction of the outcrops that the true gault and the Red Chalk must ultimately meet,—Mr. Rose, I say, has informed me that he has observed the Red Chalk and the gault incorporated together at Leziate. Henceforward to the south the Red Chalk is no more seen.

Thus, then, we have come to the termination of our journey. We have noted the beginning and the ending of the Red Chalk, we have also taken some account of its neighbours. We have noticed, too, that in Yorkshire it for the most part reposes on the Speeton clay, though in certain localities it is next the lias and Kimmeridge clay, and that in Lincolnshire and Norfolk it rests on a dark brown pebbly mass supposed to belong to the lower greensand formation of the south of England.

The Red Chalk has also been discovered in a very unexpected place, although not *in sitû*. I allude to the drift of Muswell Hill. In that collection of different materials, comprising examples from every formation from the London clay to the mountain limestone in a stratum of eighteen feet, the Red Chalk has been seen in a bouldered condition.

By the kindness of Mr. Wetherell of Highgate, I am enabled to exhibit specimens from the drift of Muswell Hill. Any person who compares them with others from Hunstanton, would declare they came from the same bed, so alike are they in appearance.

There was a time no doubt when this Red Chalk had a more extended range: its presence in the drift of Muswell Hill, as well as in the drift of other places, implies as much. Perhaps it may still exist elsewhere, deep down in the earth.

In a well sunk at Stowmarket a red substance was found under the White Chalk, at a depth of 900 feet; and in another well sunk at Kentish Town, the workmen met, at a depth of 1,113 feet below the surface, beneath the gault, a bed of red matter 188 feet thick—some of this red matter appeared to contain belemnites.

Geologists are divided in opinion with respect to this deep-sunk red bed, which certainly is not always continuous (for instance, it was not found at a boring at Harwich), and some incline to the opinion that it belongs to the New Red, others that it is the equivalent of what is styled the Red Chalk. But it is difficult to give a solution at present. It is certain that in the gault formation, or near it, beds of a red colour are occasionally found. Near Dorking the lower greensand is capped by a local bed of bright red clay, eight feet thick. And examples of red clays from the gault of Ringmer in Sussex and Charing in Kent can be seen in the Museum of the Geological Society of London. Whether they have any relation with the Red Chalk proper of England depends upon the position which is given to that formation.

Geologists generally consider the Red Chalk as really equal to the Gault. Many of the fossils certainly are gault species; others no doubt belong to the Lower Chalk; and, therefore, probably it is better to regard it as an intermediate formation between the Lower Chalk and the Lower Greensand, which comes into being when the Gault and Upper Greensand have almost thinned out.

One of the members of our Committee, Mr. Rickard, has been good enough to make me an analysis of the Red Chalk of Speeton and Hunstanton. The Speeton is as follows:—

Carbonate of lime, with a little alumina	81.2
Peroxide of iron	4.3
Silica	14.5
	100.

From Hunstanton—

Carbonate of lime, with a little alumina	82.3
Peroxide of iron	6.4
Silica	11.3
	100.

The latter of which agrees remarkably well with the colour of the specimen, for the Red Chalk of Hunstanton is brighter than that of Speeton.

Two specimens of the borings of Kentish Town, one a red argillaceous and the other a siliceous mass, gave the following results:—

Argillaceous—

Peroxide of iron	6.5
Carbonate of lime	13.5
Silica and alumina (chiefly the latter)	80.0
	100.

Siliceous—

Peroxide of iron	2.5
Carbonate of lime	23.5
Silica, with a little alumina	74.0
	100.

Whether any connexion can be traced between these last two and the two former, I leave for others to decide.

The following list of books may perhaps be useful to those who wish to further investigate the subject:—In

Professor Phillips' Geology of Yorkshire,
Young and Bird's Survey of the Yorkshire Coast,
Dr. Fitton's Memoir of the Strata below the Chalk,
Taylor's Hunstanton Cliff (Phil. Mag. vol. lxi.),
Woodward's Geology of Norfolk,
Rose on the Geology of West Norfolk (Phil. Mag. for the years 1835 and 1836),

will be found some account of the English Red Chalk. And in

Sedgwick and Murchison on the Structure of the Eastern Alps (Geol. Soc. Trans. vol. iii. Second Series),
Sir. R. I. Murchison on the Geological Structure of the Alps (Quart. Geol. Journal, vol. v.),
Prof. T. A. Catullo on the Epiolitic Rocks of the Venetian Alps (Quart. Geol. Journal, vol. vii.),
Count A. de Zigno on the Stratified Formations of the Venetian Alps (Quart. Journal Geol. Soc. vol. vi.),

will be seen an outline of the Scaglia or Red Chalk of Italy.

By the kindness of Dr. Bowerbank, Messrs. Wetherell, Bean, Leckenby, and Rose, in permitting me to see the specimens in their respective cabinets, and to whom, as well as to Mr. Rupert Jones, I must express great obligations for much valuable information, the accompanying list of the Red Chalk fossils of Speeton, Hunstanton, and Muswell Hill has been compiled. To the Council of the Geological Society, I have been also indebted for permission to figure from the Society's Museum the Inoceramus Crispii, in the Proceedings of the Geologists' Association.

LIST OF FOSSILS FROM THE RED CHALK.

	Speeton.	Hunstanton.	Muswell Hill.
Cristellaria rotulata, D'Orb. Sowerby's Min. Conchology, tab. 121, page 45. (In the collection of Mr. Jones.)	×		
Siphonia pyriformis Goldfuss Petrifacta, tab. 6, fig. 7, page 16. (In the collection of Mr. Rose.) This is probably the head of the next.		×	
Spongia paradoxica Geol. Trans. 2, tab. 27, fig. 1, page 377. (In the collections of Mr. Rose and Author.)		×	
Bourgueticrinus rugosus D'Orbigny's Hist. des Crinoides, tab. 17, fig. 16—19. (In the collections of Mr. Rose and Author.)		×	
Pentacrinites Fittonii Austin's Crinoids, page 125. (In the collections of Mr. Rose, Author, and Mr. Wetherell.)	×	×	×
Cardiaster suborbicularis, Forbes Gold. tab. 45, fig. 5, page 148. (In the collections of Mr. Rose and Author.) Mr. Rose's specimen is far better than the one figured.		×	
Cidaris Gaultina (?), Forbes, Dec. v. (In the collection of Mr. Rose.)		×	
Spines with 8 ridges, 10 ridges, and 20 ridges (In the collections of Mr. Rose and Mr. Wetherell.)		×	×
Diadema tumidum, Forbes, Dec. v. (In the collection of Mr. Rose.)		×	
Serpula antiquata Sow. Min. Con. tab. 598, fig 4, page 202. (In the collection of Mr. Rose.)		×	
Serpula irregularis (In the collection of Author.)		×	
Serpula triserrata. See notice, page 18 (In the collection of Mr. Rose.)		×	
Vermicularia umbonata Mantell's Geol. of Sussex, tab. 18, fig. 24, page 111. (In the collections of Mr. Rose and Author.)		×	
Vermicularia elongata, Bean MS. (In the collections of Mr. Bean, Dr. Bowerbank, and Author.)	×		
Cytherella ovata, Rœmer Jones, Cretaceous Entomostraca. Pal. Soc. page 29. (In the collection of Mr. Jones.)	×		
Idmonea dilatata D'Orbigny's Terrains Crétacés, tab. 632. (In the collection of Mr. Bean.)	×		
Diastopora ramosa, Dixon Geol. Suss. page 295. (In the collection of Author.)		×	

	Speeton.	Hunstanton.	Muswell Hill.
Ceriopora spongites . . . . Goldfuss, page 25, tab. 10, fig. 14. (In the collection of Author.)	×		
Terebratula capillata . . . . Davidson's Cretaceous Brachiopoda, plate 5, fig. 12, page 46. (In the collections of Mr. Rose and Author.)		×	
Terebratula biplicata . . . . David. plate 6, fig. 34. (In the collections of Dr. Bowerbank, Mr. Rose, and Author.)		×	
Terebratula Dutempleana . . . . David. plate 6, fig. 1. (In the collection of Mr. Rose.)		×	
Terebratula semiglobosa . . . . David. plate 8, fig. 17. (In the collections of Dr. Bowerbank, Mr. Bean, and Author.)	×	×	
Kingena lima . . . . David. plate 5, fig. 3, page 42. (In the collections of Mr. Rose and Author.)		×	
Avicula, cast of. (In the collection of Mr. Bean.)	×		
Exogyra haliotoidea . . . . Sow. M. C. tab. 25, page 67. (In the collections of Mr. Rose and Author.)		×	
Inoceramus Coquandianus . . . . D'Orb. Ter. Crét. tab. 403, fig. 6—8. (In the collection of Author.)	×		
I. Crispii . . . . Mant. G. S. tab. 27, fig. 11, page 133. (In the collections of Mr. Rose and Geol. Soc.)		×	
I. tenuis . . . . Mant. G. S. page 132. (In the collections of Mr. Rose and Mr. Wetherell.)		×	?
I. gryphæoides . . . . Sow. M. C. tab. 584, fig. 1, page 161. (In the collection of Mr. Rose.)		×.	
I. læviusculus, Bean . . . . (In the collection of Mr. Bean.)	×		
I. sulcatus . . . . Sow. M. C. tab. 306, page 184. (In the collection of Mr. Rose.)		×	
Ostrea frons. Park. . . . . Sow. M. C. tab. 365, page 89. (In the collection of Mr. Wetherell.)			×
O. vesicularis, Lam. . . . . Sow. M. C. tab. 392, page 127. (In the collection of the Author.)		×	
O. Normaniana . . . . D'Orb. tab. 488, fig. 1—3, page 746. (In the collection of Mr. Rose.)		×	

	Speeton.	Hunstanton.	Muswell Hill.
Pecten Beaveri Sow. M. C. tab. 158, page 131. (In the collection of Mr. Rose.)		×	
Spondylus latus Sow. M. C. tab. 80, fig. 2, page 184. (In the collection of Mr. Rose and Author.)	×	×	
Ammonites alternatus ? Woodward, Geol. Norfolk, tab. 6, fig. 23.		×	
Ammonites complanatus Sow. M. C. tab. 567, fig. 1. (In the collection of Mr. Rose.)		×	
A. rostratus Sow. M. C. tab. 173, page 163. (In the collection of Mr. Rose.)		×	
A. serratus, Parkinson Sow. M. C. tab. 308, page 3. (In the collection of Mr. Rose.)		×	
Belemnites attenuatus Sow. M. C. tab. 598, fig. 2, page 176. (In the collection of Author.)		×	
B. minimus Sow. M. C. tab. 598, fig. 1, page 175. (In the collections of Messrs. Bowerbank, Bean, Rose, Wetherell, and Author.)	×	×	×
Belemnites Listeri Phil. Geol. York. tab. 1, fig. 18. (In the collection of Author.)	×		
B. ultimus, D'Orb Sharpe, Chalk Moll. tab. 1, fig. 17. (In the collections of Mr. Bean and Author.)	×		
Nautilus simplex Sow. M. C. tab. 122, page 122. (In the collections of Mr. Rose, Mr. Wetherell, and Author.)		×	×
Otodus appendiculatus Ag. vol. iii. page 270, tab. 32. (In the collection of Mr. Wetherell.)			×
Tooth of Saurian (In the collection of Mr. Bean.)	×		
Vertebra of Polyptychodon (?) (In the collection of Author.)		×	

Siphonia pyriformis is probably the head of Spongia paradoxica. In the cabinet of Mr. Rose is a mass of the latter, to which a head similar to the one figured is attached.

Bourgueticrinus rugosus. The diameter of the specimen figured is $\frac{3}{4}$ of an inch, the depth of each plate $\frac{3}{16}$. The surface of attachment is covered with very fine mamillæ, in rays of seven in number; a smaller specimen in possession of the author measures $\frac{3}{8}$ of an inch in diameter and $\frac{1}{8}$ in depth.

The serpula represented in Plate III. fig. 3 varies in its irregular growth from the specimens figured on the same plate. This character perhaps can scarcely be regarded as a specific difference; both V. elongata and the serpula under consideration have the same thickness of the calcareous tube. The former occurs only at Speeton and the latter at Hunstanton; in order to distinguish the two, the title "irregularis" may be applied to the latter as a variety.

Serpula triserrata, a species found on a specimen of Ammonites complanatus, is distinguishable by its three serrate longitudinal ridges. A similar form occurs on ostreæ from the Kimmeridge clay of West Norfolk.

Terebratula semiglobosa is common at Speeton, but very rare at Hunstanton. T. biplicata is very common at Hunstanton, but is not known at Speeton.

Inoceramus læviusculus, Bean, a large smooth species something like I. Cuvieri.

The Ammonites alternatus of Woodward is now lost; it was probably a variety of A. serratus, Park.

Belemnites minimus is sometimes two inches long in the Hunstanton Cliff.

The vertebra of Polyptychodon would be, if perfect, about six inches in diameter and three in thickness.

The small specimen figured in Geologists' Association Proceedings, Plate II. fig. 9, evidently belongs to the Turbinolian family of corals, and possibly, to the genus Trochocyathus instituted by Messrs. Milne-Edwards and J. Haime, in 1848. The specimens as yet obtained are not sufficiently numerous nor perfect for a rigid comparison with other forms, or to admit of a sufficiently detailed description should the species prove to be new. The constricted form of growth is very common in the Parasmilia of the Upper Chalk, and has no specific value.

The characteristic fossils of the Red Chalk at Speeton are Terebratula semiglobosa, Belemnites minimus, and Vermicularia elongata; and at Hunstanton, Terebratula biplicata, Belemnites minimus, and Spongia paradoxica.

FOREIGN CORRESPONDENCE.

Notices of the Meteorite of Tulbagh and of the Tertiaries of Horn. Read before the Imperial Academy of Sciences, Vienna, 7th March, 1859. *Communicated by* COUNT MARSCHALL.

1.—*Meteoric Stones.*

THE meteorite which fell, Oct. 13, 1838, near Tulbagh, Cold Bokkeveld (Cape of Good Hope), already analyzed by Prof. Faraday, has been submitted to a new investigation by Mr. Harris, in Prof. Wöhler's laboratory at Göttingen. This meteorite, in its black, opaque, and soft substance, greatly resembles that of Kaba (Hungary).

The analysis discovered in it 1.67 per cent. of carbon, and 0.25 per cent. of the same bituminous substance as was met with in the Kaba meteorite, a substance declared by Prof. Wöhler to be of undoubtedly *organic* origin. The inorganic constituents found in this meteorite are, iron, 2.50; nickel, 1.30; sulphur, 3.38; silica, 30.80; oxydulated iron, 29.94; magnesia, 22.20; lime, 1.70; alumina, 2.05; oxide of chrome, 0.76; potash and soda, 1.23; oxide of manganese, 0.97; copper, 0.03; vestiges of cobalt and phosphorus, deficit, 1.22

per cent., a composition greatly analogous to that of the Kaba stone. According to Prof. Wöhler's views the *mineralogical* composition of the Tulbagh meteorite may be expressed by the formula: ferrugineo-magnesian olivine, 84.32; indecomposable silicate, 5.46; sulphuret of iron and nickel, 6.94; chromate of iron, 1.11; carbon, 1.67; organic bituminous substance, and traces of copper, cobalt, and phosphorus. The first small specimens of the Tulbagh meteorite came into the possession of the Vienna Imperial Museum through M. de Struve, then resident Minister of Russia at Hamburgh; subsequently a fragment of 12½ ounces was purchased from Dr. Krauss; and Sir John Herschel himself presented the Museum with a specimen of 6½ ounces from the fragments sent to him by Mr. Maclear, the first scientific observer of the phenomenon.

The total bulk of the meteorite, partly shattered by its having fallen on stony ground, has been estimated to exceed five cubic feet.

2.—*Tertiaries of Horn (Lower Austria).*

These tertiaries, reposing on the crystalline rock-masses of the Manhartsberg, have attracted Dr. Rolle's attention on account of their fossil remains, which partly indicate an age earlier than that generally of the Vienna basin. They include, comparatively to the other Vienna strata, a greater number of gasteropods, indicative of the inferior tertiaries, with a smaller proportion of recent forms; so that they may justly be considered the most ancient of the Vienna basin, those of Grund following immediately above them, and the ascending series of marine deposits being closed by those near Baden, Vös, Pau, &c. Dr. Rolle's observations afford a new proof of the non-existence of any strictly determinable limit between the faunæ of the neogene (upper miocene and pliocene) and of the oligocene and upper eocene deposits, overlying immediately the first, several organic forms being common to both divisions, in the same way as neogene species have continued to exist amid those of the present creation.

BY DR. T. L. PHIPSON, OF PARIS.

Discovery of Selenium and Tellurium at Vesuvius—New Minerals observed by MM. Napoli and Palmieri—Metamorphism undergone by Eruptive Rocks—A few Facts connected with the Physical Geography of the Hautes-Alpes.

One of the most interesting discoveries that have been made for some time past in mineralogy is the following, which we owe to M. Raphael Napoli, professor of chemistry at Naples:—On examining the lava which has been emitted almost constantly by Vesuvius for the last twelve months or more, M. Napoli found that it contained a considerable proportion of selenium and tellurium, combined with titanium, iron, and lead.

As the lava cools, the sulphurous acid vapours, which are exhaled in abundance from it, partially destroy these combinations of selenium and tellurium, producing a great quantity of pure selenium, which is deposited, and oxides of selenium and tellurium, which are disengaged and emitted into the air in a gaseous state and in large proportions.

Pure Selenium is thus deposited in the cavities and crevices of the lava, and in the interior of the solidified mass. No one had ever remarked this before. Doubtless Selenium has often been seen in the fissures of lava, but from its red colour it has evidently been as often mistaken for oxide of iron.

To chemists and mineralogists this discovery is of the highest interest. Both tellurium and selenium are such rare substances that they are only known as curiosities of the laboratory; and few laboratories indeed possess specimens of either.

Up to the present time, tellurium has been found, but very rarely, combined with gold, silver, lead, and bismuth, in the mines of Transylvania. In appearance it resembles autimony. It was discovered, in 1782, by Müller, of Reichenstein, and its principal properties were made known by the then eminent chemist Klaproth.

Selenium, which bears much analogy to sulphur, was discovered, in 1817, by the celebrated Berzelius. It has hitherto been found only as seleniuret of lead, a rare mineral, or combined in certain varieties of iron-pyrites. A native seleniuret of copper was discovered some years ago, and called Berzeline, in honour of the great chemist whom we have just named. Before the interesting observations of M. Napoli, selenium had never been found in nature otherwise than in combination with substances. M. Napoli has also described a new substance, which appears to be a combination of lead and selenium, discovered by M. Palmieri, the distinguished meteorologist of Vesuvius, in certain *fumarolle*, and which has been named Sacchite, in honour of Professor Sacchi, of Naples. A peculiar white substance has likewise been observed. This substance exists in the crevices of the lava, whence it is easily volatilised, mixes itself with the air, absorbs moisture, and falls again, forming a sort of crust on the surface of the beds of lava. It appears to be another combination of selenium, not yet thoroughly known. We shall return again to these new minerals when we have seen M. Napoli's memoir; we may already affirm that a new mine of interesting mineral and chemical products is open at Vesuvius, and promises fairly to be a rich one.

We now resume M. Delesse's researches on metamorphism. In THE GEOLOGIST for May last we terminated our sketch of the effects produced upon the different stratified deposits by the upheaval of igneous or plutonic rocks. We will now inquire how the igneous or eruptive rock itself is modified while acting upon the strata it has uplifted.

The metamorphism of the eruptive rock (whatever be its nature) is generally less characteristic than that of the strata uplifted. M. Delesse thinks this is easy to account for, as the latter were solid at the time the phenomenon took place, and consequently not in a condition to exercise a reaction upon the plutonic rock. This is, however, an insufficient reason, and M. Delesse's own observations show that even where no change or metamorphism is apparent in the uplifting rock, a few simple tests will enable us to affirm that a change has really taken place. When the plutonic rock is examined comparatively (in a large vein, for instance) at its borders and at its centre, it is remarked to have undergone a modification, not only in its structure, but also in its composition. Such modifications do not, however, extend more than a few inches from the borders; they are more marked in smaller veins, and more visible in lava and traps than in granite rocks.

Near the borders of a vein of rock its structure has become schistose, prismatic, granular, amygdaloïdal, &c., according to circumstances. The density of the rock has diminished in these parts, and this is very notable in the case of trap-rocks. The quantity of water which it contains has, on the contrary, augmented.* In some cases structure alone has been modified; but in most the composition of the rock is changed also. Sometimes this composition is exactly intermediate between that of the uplifting and that of the upheaved rock.

Among the minerals found in the eruptive rock near the parts in contact with the uplifted strata, M. Delesse indicates carbonates and quartz; also, different silicates, principally garnet, idocrase, and epidote. But when the reaction that has taken place between the two rocks has been very active, a complete exchange or mixture of elements has been operated.

Metalliferous lodes are often seen [illegible] in the uplifted or in the plutonic rock. They penetrate both, and are most abundant at the points of contact.

As concerns minerals produced during metamorphism by contact, they are very numerous, as we have already shown in our preceding papers, and they are much the same for the plutonic rock and the strata which it has uplifted. In numerous cases these minerals have been formed from the elements of the one and the other. Quartz and spathic carbonates are very frequent where either the eruptive rock or the other contains silica and carbonates. Zeolites are more especially associated with volcanic rocks, such as lava, basalt, and trap. Tourmaline, with granitic rocks. The numerous silicates for which M. Dana formerly established the types garnet and pyroxene have been formed in the eruptive rock, and in the uplifted strata.

M. Charles Martins, the eminent botanist of Montpellier, informs us that he has discovered, among some notes taken during several scientific excursions made by him at different times, a striking proof of the correctness of a theory he propounded some time ago to establish that on mountain ranges the soil must be heated by the solar rays to a greater extent than the air; whereas in flat countries or plains the contrary must take place. The theory indicates, and experiment proves, that our atmosphere absorbs a considerable portion of the heat which comes from the sun to the earth. M. Pouillet estimates this quantity at four-tenths of the entire heat arriving at the earth from the sun at any given moment.

---

* This is probably one of the chief causes of the diminution of specific gravity. —T. L. P.

A sunbeam falling upon an elevated mountain-top traverses a much thinner layer of atmosphere than one which falls upon a soil level with the sea; the former must therefore distribute more heat to the summit of the mountain than the ray which continues downwards until it reaches the level of the sea can bestow upon the soil of the plain.

But the rarefied atmosphere of the mountain-top is less heated than the more condensed air of the plain. It remains evident then, that the soil of a mountainous elevation, at its surface, and at some inches below the surface, must each day be heated by the sun to a higher degree than the air which reposes upon it; whilst precisely the reverse must take place on plains which are only a little above the level of the sea.

The correctness of this theory is demonstrated by certain observations made on the Faulhorn (Alps) in August, 1842, by MM. Bravais and Peltier, and in September, 1844, by MM. Bravais and Ch. Martins, when compared with corresponding data collected at Brussels by M. Quetelet, and at Spitzbergen, in 1839, by the meteorological commission attached to the expedition of the ship *La Recherche*.

This relative elevation of the temperature of the soil exercises a powerful influence upon the physical geography of the Hautes-Alpes. To it alone must be attributed the rise of the snow-line. Any traveller who has visited these elevated regions knows that the snow is melted underneath by the heat of the ground. Often he must have remarked that when he placed his foot upon the border of a field of snow, the weight of his body caused the superficial crust to break, and observed that this crust does not repose upon the ground. Sometimes, under such icy vaults he will have seen with astonishment flowering soldanella (*Soldanella Alpina*, L., and *S. Cludii*, Thom.) and rosettes of dandelions! It is this melting of the snow which is in contact with the warmer soil that causes those immense fields of frozen water to slide down the verdant slopes and form terrible avalanches in the spring. Finally, to the warmth of the soil in these high regions must be attributed the presence of so great a variety of vegetable species, and such numbers of plants, which cover the soil at the very limits of perpetual snow. On the conical summit of the Faulhorn, at a height of 8,800 feet above the level of the sea, M. Charles Martins collected 131 species of phanerogamic plants. At the Grands-Mulets, on peaks of schistous protogine which rise from the centre of the glaciers of Mont-Blanc, 10,000 feet above the sea, 19 species were observed:—*Draba Fladnizensis*, Wulff.; *Cardamine*

ellidifolia, L. ; *Silene acaulis*, L. ; *Potentilla frigida*, Will. ; *Phyteuma hemisphæricum*, L. ; *Erigeron uniflorum*, L. ; *Pyrethrum alpinum*, Willd. ; *Saxifraga bryoïdes*, L. ; *S. Grœnlandica*, Lap. ; *S. muscoïdes*, Martins ; *Androsace Helvetica*, Gaud. ; *A. pubescens*, D. C. ; *Gentiana verna*, L. ; *Luzula spicata*, D. C. ; *Festuca Halleri*, Will. ; *Poa laxa*, Haenke. ; *P. cæsia*, Sm. ; *Agrostis rupestris*, All. ; and *Carex nigra*, All.

Also, on the 28th June, 1846, the temperature of the air in the shade being 9° 4′ (centigrade), and in the sunshine 11° 4′, the schistose gravel in which these plants grew showed a temperature of 29°. Spitzbergen, the shores of which may also be said to touch upon the snow-line, shows us, on a space of ground infinitely larger, only 82 species of phanerogamic plants.

On the Alps plants are warmed by the soil in which they grow far more than by the air which surrounds them ; a bright light favours their respiratory functions ; and so soon as the temperature descends to zero during the day a layer of recent snow preserves them from the accidental cold which generally accompanies bad weather on high mountain-ranges. Equally sensitive to cold and to heat, they can only endure a temperature ranging from 0° to + 15°. Continually moistened by the damp clouds and the wet which drops from the melting snow, they would require the most careful culture to flourish in the plains below, for the horticulturist would have to protect them at once from the chills of winter and the heat of summer, giving them constant humidity and bright light.

At Spitzbergen, on the contrary, in spite of the perpetual day which reigns during the summer, vegetation is poor and scanty, because the sunbeams, mostly absorbed by the great depth of atmosphere they traverse, and by the continuous mists, have not power to vivify by their light or by their warmth its icy ground.

Notes read before the Imperial Geological Institute of Vienna. Favoured by COUNT MARSCHALL, *of Vienna.*

1.—*Metalliferous Strata of Rochlitz, on the Southern Slope of the Bohemian Sudets.*

The author of a monograph on these strata is the lately deceased Mr. E. Porth, who in 1853 successfully undertook the re-opening of the old mines in this district, abandoned some centuries ago under the pressure of unfavourable circumstances. The ores occur in a series of calcareous strata, intimately connected with the schistose quartzite of the micaceous and argillaceous schists of the South Sudets, and under circumstances analogous to those of the Scandinavian metalliferous deposits. Large masses of a mineral substance, similar to malacolite, are impregnated with sulphurets of copper, lead, zinc, and iron. With these occur, in predominant proportions, hydrosilicates of copper, malachite, green carbonate of copper, and other minerals containing this metal in the condition of an oxide.

2.—*Sulphuriferous Strata in the Roman States.*

Sulphur is found in a calcareous marl (Upper Cretaceous) in the environs of Rimini and Cerena. The thickness of the most productive beds varies from about four to thirty-one feet. During 1857, 680 workmen produced above 10,000 cwts. of smelted sulphur. These mines are the property of a company of shareholders, having a capital of 220,000 scudi. A considerable proportion is sent, in the form of powder, to the Levant, where it is used to preserve vines against the ravages of the Oïdium.

3.—*Mineral Springs of Goritzia and Istria.*

The Montefalcone spring is situated about 2,000 paces from the sea-coast, in a natural basin, seven feet deep, twenty-eight feet long, and as broad; of nearly regular square form, and excavated in cretaceous limestone. The basin is without an outlet. The water-level rises and falls with the sea-tides, and is spontaneously restored when lowered by exhaustion. The temperature is 37° or 38° cent.; the taste is similar to that of sea-water; the smell slightly sulphuretted (like that of the surrounding limestone when freshly fractured), but transient. The surrounding swamps contain fresh water.

This mineral water contains, in 10,000 parts, 133.71 parts of solid substances, among which chloruret of natrium (96.06), chloruret of magnesium (15.32), bicarbonate of lime (1.83), sulphates of potash, natron, and lime (2.44, 6.51, and 8.76), are predominant.

The sulphurous spring of San Stefano lies about twenty English miles from the sea, and nearly twenty feet above the sea-level. Its quantity is very considerable. Temperature 36.5° to 37.5° cent. (temperature of the surrounding air 22° to 26° cent.). Taste, lixiviously insipid. Proportion of fixed substances very considerable. The strong hydrosulphurous smell, the thick white deposit, and the instantaneous deep blackening of silver coins thrown into the water, denote a considerable proportion of sulphur contained in it. There may exist a connexion between this spring and the alum-shales of Sovigniaco, not far distant.

Notices of some Meteorites, by Dr. Hörnes, Professor Wöhler, and Director W. Haidinger. Read before the Imperial Academy of Sciences, Vienna, July, 1858, and January, 1859. Communicated by COUNT MARSCHALL, *of Vienna.*

1.—*On the Meteorite of Ohaba (Transylvania).* BY DR. HÖRNES.

This meteorite fell in the night, between October 10th and 11th, 1857, at Ohaba, east of Carlsberg, in Transylvania, and was subsequently acquired for the Imperial Mineralogical Museum of Vienna. Soon after midnight of October 10th, the curate of Ohaba was frightened out of his sleep by a thunder-like noise, attended by a fiery mass moving through the serene atmosphere, in a descending direction, and finally falling on the ground with a stunning detonation. Next morning, the meteorite was found in an orchard, where it had penetrated the tough, moss-covered ground. It is completely covered with the black crust peculiar to meteorites; its shape is that of an irregular trilateral pyramid, fourteen and a half inches high; two of the irregularly curved surfaces are smooth, the third and the basal one exhibit the characteristic round impressions.

A fresh fracture at the base exhibits the interior, of a light green colour, slightly tinged with dark bluish grey, with indistinct spherical concretions, a great plenty of coarse and fine particles of metallic iron, very minute particles of magnetic sulphuret of iron, and a very scarce admixture of olivine. The crust is thin and opaque.

This meteorite is very similar to that of Château-Renard (June 12th, 1841; weight, between 70 and 80 lbs.); and on account of the indistinct form of its spherical concretions, it must take its place amongst Partsch's "Normal Meteorites." It weighs 29 lbs.; its specific gravity is 3.11. An analysis, made by Dr. Buckeisen, in Professor Wöhler's laboratory, proved it to be a compound of olivine, augite, and a felspar-like mineral, with interspersed particles of metallic and sulphuretted iron.

2.—*On the Meteorite of Kaba (Hungary).* BY DR. HÖRNES.

This meteoric stone fell April 15th, 1857, near Kaba, south-west of Debreczin, in Central Hungary. About 10 P.M. an inhabitant of Kaba, sleeping in the open air, was awakened by a noise, different from that of thunder, as he described it, and perceived in the serene sky a luminous globe, of dazzling brightness, following a parabolic course during four seconds. This phenomenon was observed by several inhabitants of the same place. As one of them was riding out the next morning, his horse was frightened by the sight of a black stone, deeply bedded in the soil of the road, the ground around it being depressed and creviced. When dug out the meteorite weighed about 7 lbs. The finder broke off some fragments, and the remainder, weighing 5½ lbs., was deposited in the Museum of the Reformed College at Debreczin. This meteorite has the shape and size of a small loaf of bread. Its crust is black, covered with concentrically radiate furrows and tubercles. Its mass is greyish-black with globular concretions, and acts energetically on the magnetic needle. Its internal structure, in general features different from that of any meteorite hitherto known, most resembles in its structure that which fell at Renazzo.

The Kaba meteorite has been found to contain a certain quantity of carbon, together with another substance into the composition of which carbon enters. Professor Wöhler, of Göttingen, found the composition of this substance to bear a great analogy with certain minerals of a wax-like constitution, such as ozokerite, scheererite, &c., which are all carburets of hydrogen.

3.—*On the Meteorite of Kakowa (Banat).* By Professor Wöhler and M. Haidinger.

The fall of this meteoric stone, on May 19th, 1858, at 8 A.M., was attended with the usual phenomena: a small black cloud in the air, a hissing and thunder-like noise, heard at two Austrian (five English) miles distance, a short and loud explosion at the moment when the stone—in a state of considerable heat—touched the ground, into which it penetrated to a depth of three inches. Lieutenant-General Count Coronini, Governor of the Banat, sent the stone to the Imperial Geological Institute, and it is now added to the rich collection of meteorites in the Imperial Museum of Mineralogy.

The meteorite of Kakowa (although complete as in the moment of its fall) bears the appearance of being a fragment from a larger mass, with markedly rounded angles and edges, and a black cortical substance, about half an inch thick, extending into the interior in the shape of a vein. Minute particles of metallic iron are nearly uniformly spread throughout the whole stone.

Professor Wöhler submitted it to an analysis. The portions extracted by the magnet give: metallic iron, 82.95; nickel, 11.41; cobalt, 1.08; and inappreciable quantities of phosphorus, copper, and oxide of chrome.

The analysis by means of carbonates of potash and soda gave: silica, 41.14; magnesia, 27.06; oxidulated iron, 27.47; lime, 0.68; and some oxidulated manganese.

luoric acid decomposed the substance of the meteorite into: 1.96; magnesia, 27.06; oxidulated iron, 23.95; alumina, 2.46; lime, 0.81; oxidulated manganese, 0.39; soda, 1.92; potash, 0.56; graphite, 0.15; nickel, 0.20; and sulphur, a trace.

Hydrochloric acid reduced it into undecomposed silicates, 43.3, and decomposed silicates, 56.7; these last giving, by means of further operations, a per centage of silica, 19.5; magnesia, 11.2; oxidulated iron, 24.4; nickel, 0.2; lime, 0.7; and sulphur, a trace; so that they may be considered to be a mineral substance analogous to *olivine*, with a very large proportion of oxide of iron, as occurs in many other meteorites. The per centage of the insoluble portion is: silica, 50.49; magnesia, 36.84; lime, 1.88; alumina, 5.71; soda, 4.45; and potash, 0.59; representing, according to Sartorius von Waltershausen, an aggregate of 82.17 of magnesian wollastonite, and 17. of anorthite, with the difference only that these two minerals as they generally occur are decomposable by acids.

Mr. Haidinger added some remarks on the theory of meteorites, tending to prove that the opinion of the formation of meteorites by immediate aggregation of the gaseous or extremely subtle matters dispersed through the cosmic spaces, is, in all probability, very far from the truth. A temperature of from 50° to 91° cent. (as calculated to exist within these spaces) is a very unfavourable condition for the crystalline arrangement of material atoms. It is more probable that a reaction from the interior to the surface is going on within an already formed aggregate of substance, which, by mutual and opposite pressure, and with the assistance of heat (a natural consequence of it), shapes the component particles into a stone-like compound. Subsequent eruptions may then have detached and thrown off minor portions of the whole, and of these some reach the surface of the globe. Humboldt, in his "Cosmos," alludes to the improbability of a sometimes highly developed crystallizing process going on during the brief time of the passage of meteorites across the terrestrial atmosphere.

On the Fossil Mammalia of the Vienna Tertiary Strata. BY PROFESSOR E. SUESS. *Read before the Imperial Academy of Sciences, Vienna, June,* 1858. *Communicated by* COUNT MARSCHALL.

The supposed complete identity of the faunæ of the Leitha limestone, the Congeriæ-beds, and the sands of Belvedere (Vienna), does not really exist, although a few species are found throughout the whole series. The species of *Hippotherium* and *Sus* peculiar to the Congeriæ-beds and the Belvedere sands are nowhere co-existent with the *Psephophorus* and the *Cervidæ* of the Leitha limestone. *Dinotherium* seems to be common to both these faunæ. The remains of mastodons, long ago identified with the species, from Eppelsheim, described by Professor Kaup (for instance, the ramus of a lower jaw, found by Count Breunner, near Kremms, in Lower Austria, and figured by Cuvier as *Mastodon angustidens*, the two rami of a lower jaw, and the large tusk from the upper jaw, found at Belvedere in 1827, and described by Dr. Fitzinger, under the same denomination, and later by Professor Kaup,* who had received a sketch of it from Professor Suess, as *M. Arvernensis*), must all be placed in the group of *Tetralophodontes*. A lower jaw from Belvedere, in Professor Leydolt's possession, having on each side a rather long tusk, with straight longitudinal flutings, may have belonged to a male individual, while the other specimens, above enumerated, may have belonged to females. Professor Suess, in accordance with Dr. Falconer's Monograph,† assigns to this species the name of *Mastodon* (*Tetralophodon*) *longirostris* (although retracted by Professor Kaup himself), reserving the specific name *M. Arvernensis* for the species with alternating, not opposite, dental protuberances.

The only known specimen of a *mastodon* found in the Leitha limestone was found in 1816, near Loretto, and is preserved in the Imperial Museum of Vienna. It is a ramus of the lower jaw from a young individual. It is essentially different from all the remains found in the sands of Belvedere, and belongs, on account of its dental structure, to the group of *Trilophodontes*.

According to the author, like differences hold good with the several species of *Rhinoceros* from these localities.

On some Erratic Phenomena in Hungary. By Professor E. Suess. *Read before the Imperial Geological Institute of Vienna, July*, 1858. *Communicated by* Count Marschall.

Erratic phenomena on the west side of the Rosalia Mountain-group (between Lower Austria and Hungary) were made known some years since by MM. de Morlot and Czjzek. Similar phenomena have recently been traced out by Prof. Suess on the eastern or Hungarian slope, in the Ratterer ravine near Marz. A deposit of irregular and rounded fragments, derived from the neighbouring mountains (Schneeberg, Wechsel, and Neuewelt), lies, several fathoms thick, beneath the loess. The calcareous fragments exhibit distinct ice-groovings, and some show the chain-like perforations made by the *Voia*; and there are shells of an oyster (very like *Ostrea edulis*) fixed on the blocks and directly upon the glacial grooves. The intercalated sandy beds contain fragments of a *Nucula* or *Yoldia*, and internal casts of a bivalve referable to the family of the *Lucinæ*. From these facts the author infers that this portion of the Vienna Basin, after having gradually passed, during the neogene (younger tertiary) period, from the condition of a marine bay into that of a fresh-water lake, again underwent an irruption of the sea.

---

* Beiträge zur nähern Kenntniss der urweltlichen Säugthiere, vol. iii. 1857, Pl. II. fig. 3.

† Quart. Journ. Geol. Soc., vol. xiii. p. 307.

Further researches may clear up the relation of these faunæ with the glacial faunæ of the Frith of Clyde and of Uddewaller, and throw perhaps some new light on the analogies between the younger molluscan faunæ of Sicily and England, at first so ingeniously exposed by the late Prof. Edward Forbes.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London.—*May 4th*, 1859. The following communications were read:—

1. "On the Ossiferous Cave, called 'Grotta di Maccagnone,' near Palermo." By Dr. H. Falconer, F.R.S., F.G.S.

In a letter, dated Palermo, March 21, 1859, and addressed to Sir C. Lyell, V.P.G.S., Dr. Falconer first states, that from the caves along the coast between Palermo and Trapani he has lately obtained remains of *Elephas antiquus*, *Hippopotamus Pentlandi*, *H. siculus*, *Sus priscus* (?), *Equus*, *Bos*, *Cervus intermedius* and another species, *Felis*, *Ursus*, and *Canis*, and coprolites of *Hyæna;* but no remains of *Rhinoceros*, nor of *Elephas primigenius*. These additions to the previously ascertained faunæ of the cave-period in Sicily may aid in putting it in relation with the Newer Tertiary deposits of Italy.

The author then proceeds to describe the Grotta di Maccagnone, a previously undescribed ossiferous cave, in the Hippurite-limestone, westward of the Bay of Carini (between Palermo and Trapani). In the breccia below its entrance he met with remains of *Hippopotamus* in abundance, and remains of *Elephas antiquus* in the upper deposit of humus within the cave. But some other fossils were discovered under very interesting and somewhat anomalous conditions in this cave. The interior of the cavern is lined with stalagmite; and at a spot on the roof, where this is denuded, Dr. Falconer found a large patch of bone-breccia containing teeth of Ruminants, bits of carbon, shells of several species of *Helix*, and a vast abundance of flint and hornstone knives of human manufacture. At other places, and wherever the author had the calcareous coating broken by hammers, he found similar remains. At one spot, on breaking the stalagmite, he found against the roof of the cave a thick calcareo-ochreous layer containing abundance of the coprolites of a large *Hyæna*.

Dr. Falconer draws the following inferences from the study of these facts:—(1.) That the Maccagnone Cave was filled up to the roof within the human period, so that a thick layer of bone-splinters, teeth, land-shells, and human objects was agglutinated to the roof by the infiltration of water holding lime in solution. (2.) That the coprolites of a large *Hyæna* were similarly cemented to the roof at the same period. (3.) That subsequently, and within the human period, such a great amount of change took place in the physical configuration of the district as to have caused the cave to be washed out and emptied of its contents, excepting the patches of material cemented to the roof and since coated with additional stalagmite.

2. "On the Jurassic Flora." By Baron Achille de Zigno. Communicated by C. Bunbury, Esq., F.G.S.

In studying the numerous specimens of Jurassic Plants discovered in the Venetian Alps, Sig. de Zigno has found it necessary to pass in revision all the known species derived from the Jurassic strata in different countries. In preparing his large work on the Fossil Plants of the Oolitic Rocks ("Flora fossilis Formationis Oolithicæ"), two parts of which have been published, the author finds, as may be expected, some discrepancies in the published opinions as to the place which the plant-bearing beds of Scania, Richmond (U.S.), India, Australia, and South Africa respectively are entitled to in the geological scale. As the apparent weight of evidence places some of these deposits in other formations than the Jurassic, and as some are still very doubtfully placed, the author omits them from his sources of Jurassic plants.

In the two parts of his work which he has presented to the Society, the author describes the Jurassic *Calamites* (including the *Asterophyllites*), the *Phyllothecæ*, and *Equiseta*. The plates of figures accompanying the foregoing, but not yet described, are recommended by the author to the notice of English paleobotanists, as illustrative of interesting but somewhat obscure ferns; and he particularly requests that search should be made in the Oolites of Yorkshire for specimens of *Pachypteris* with pinnules having a single midrib. Sig. de Zigno supports Sternberg and Bronn in the suggestion that under the term *Equisetites columnaris* authors have confounded two distinct forms; one from Brora and Yorkshire, with thick joints, and illustrated by König; the other being found in the Lias and Trias. Some remarks on the probable relations of *Glossopteris* and *Sagenopteris* follow.

The remains of Ferns in Jurassic beds of the Venetian Alps are numerous, though the species are few. The fructification is often evident; and the epidermis of the fronds can be sometimes separated for microscopical examination. The *Cycadeæ* have more species; and the *Coniferæ* (especially the *Brachyphylla*) are numerous.

3. "On a Group of supposed Reptilian Eggs (*Oolithes Bathonicæ*) from the Great Oolite of Cirencester." By Professor J. Buckman, F.G.S.

The specimen referred to was obtained by Mr. Dalton from the Harebushes quarry near Cirencester, and presents evidence of a compact cluster of eight oval bodies (each about 2 inches long and 1 inch across) in a mass of oolitic rock. These oval bodies being equally rounded at the ends, and in this differing from birds' eggs, the author thinks that they must have been the eggs of a reptile. The egg-shells were very thin, have been here and there puckered by pressure, and are more or less occupied with calc-spar.

[The specimen was exhibited to the meeting.]

4. "On some Sections of the Strata near Oxford." No. I. By Professor Phillips, Pres. G.S.

In this communication Professor Phillips gave the details of sections showing the base and the top of the Great Oolite in the Valley of the Cherwell. This oolite, with sandy layers below and variable argillaceous beds above (capped by the Cornbrash), has been entirely referred to the Great Oolite formation by the Geological Survey, and has been traced through Northamptonshire to the cuttings in the Great Northern Railway near Stamford and Grantham; and continues through Lincolnshire to the Humber. On the north of that river this series is continued by the Oolite of Brough and Cave, and is recognised again in the Millepore-rock at the base of the Gristhorpe Cliffs. Hence it appears that the calcareous shelly beds of Gristhorpe on the Yorkshire coast are still to be assigned, as they were in earlier works, to the Great Oolite group, notwithstanding they contain a few fossils which in the South of England are prevalent in the Inferior Oolite, together with many the distribution of which is not there limited to one member of the Great or Bath Oolite series.

May 18*th*, 1859.—1. "Palichthyologic Notes, No. 12. Remarks on the Nomenclature of the Fishes of the Old Red Sandstone." By Sir P. Egerton, Bart., M.P., F.R.S., F.G.S. &c.

Premising with some remarks on the in many respects unsatisfactory condition of the nomenclature of the fishes of the Old Red Sandstone, the author refers to the late revival, by Dr. Pander, of the discussion as to the priority of Eichwald's name "Asterolepis" over the "Pterichthys" of Agassiz; and, after a detail of the circumstances of the case, Sir Philip states that there is every reason for the retention of the name *Pterichthys* for the "winged fish" discovered at Cromartie y Miller in 1831, introduced by him to the scientific world in 1839, and named *Pterichthys* by Agassiz in 1840.

The author then proceeded to offer some critical remarks on several of the genera nd species which Prof. M'Coy has described from the Old Red Sandstone *Chirolepis velox*, M'Coy, is regarded by him as a good species; but *C. curtus* as identical ith *C. Cummingiæ*, and *C. macrocephalus* with *C. Traillii*. *Chiracanthus granlispinus* and *C. pulverulentus* are regarded as good species; but *C. lateralis* is eferred to *C. minor*. *Diplacanthus gibbus* and *D. perarmatus* are accepted. The ubstitution of *Diplopterax* for *Diplopterus* is not considered necessary. *Diplopterus gracilis* appears to be a variety of *D. Agassizii*. The occurrence of *D. macrolepidotus* in Caithness, and the restriction of *D. macrocephalus* to Lethenbar and Russia, are regarded as a reason for not accepting Prof. M'Coy's view as to the identity of these two forms.

Osteolepis arenatus, stated by Prof. M'Coy to occur at Orkney, has been met with only in the Gamrie by Sir Philip. *O. brevis* is regarded as a good species, though the apparent breadth of the head has probably been misunderstood. Hugh Miller has well figured and described the cranial anatomy of this species in the "Footprints." *Triplopterus Pollexfeni* is also considered to be well established generically and specifically. Sir Philip coincides with Prof. M'Coy in classing *Dipterus* with the *Cœlacanthi*, but observes that it is distinct from *Glyptolepis*. *Dipterus* has but one anal fin. *Dipterus brachypygopterus* and *D. macropygopterus* are, in the author's opinion, synonyms; but *D. Valenciennesi* is regarded by him as distinct.

Conchodus is esteemed by the author only a provisional genus.

Sir Philip agrees with M'Coy in separating from the *Holoptychius* the large fishes of the coal-measures which have received the name *Rhizodus* from Prof. Owen. The latter have ossified vertebral columns. *Holoptychius* has decidedly two dorsal fins. Some good specimens lately obtained at Dura Den prove that *H. Andersoni* and *H. Flemingii* are specifically the same. The determination of *H. princeps* by scales alone is not regarded as satisfactory; but *H. Sedgwickii* is a good species. *Gyroptychius angustus* and *G. diplopteroides* are considered as good species of a new and important genus; but Sir Philip refers them to the *Saurodipteridæ*, not to the *Cœlacanthi*. *Platygnathus Jamiesoni*, Ag., is well founded, as proved by recent discoveries in Dura Den; but the specimen of jaw named *P. paucidens* by Agassiz is assigned to *Asterolepis* by Hugh Miller.

With regard to the *Placodermata* of M'Coy, *Pterichthys* and *Coccosteus* are the types, and *Chelyophorus* is probably a member of the family; but it is still doubtful whether *Asterolepis* and *Heterosteus* belong to it. *Cephalaspis, Pteraspis*, and *Auchenaspis* remain for the limited *Cephalaspidæ*.

Pterichthys had certainly one dorsal and two ventral fins.

Sir Philip remarks that in *Coccosteus* M'Coy and others have mistaken for vertebral centres the thick lower extremities of the neurapophyses; hence the *C. microspondylus* of M'Coy is a misnomer, and what he terms the "dermal bones of the dorsal fin reversed," in his specimen, are the hæmapophyses. Sir Philip thinks that *C. microspondylus* and *C. trigonaspis* must be regarded as synonyms of *C. decipiens*, Ag. *C. pusillus* is quoted as a good species, and probably the same as one subsequently described by H. Miller as *C. minor*.

In a supplement to this memoir Sir P. Egerton gives several extracts from unpublished letters by the late Hugh Miller, descriptive of structural characters of the *Coccosteus*. Among these notes is the description of a small well-defined *Coccosteus* which Sir Philip proposes to signalize as *C. Milleri*. [Drawings and casts, prepared by the late Mr. H. Miller, illustrated these supplemental notes.]

2. "On the Yellow Sandstone of Dura Den and its Fossil Fishes." By the Rev. John Anderson, D.D., F.G.S. &c.

In his geological remarks on Dura Den, the author described the sedimentary strata in the vicinity as consisting of (in ascending order).—1. Grey sandstone, the equivalent of the Carmylie and Forfarshire flagstones, with *Cephalaspis* and *Pterygotus*. 2. The red and mottled beds, such as those of the Carse of Gowrie, and the Clashbinnie zone with *Holoptychius nobilissimus, Phyllolepis concentricus*, and *Glyptolepis elegans*. 3. Conglomerates, marls, and cornstone, with few and obscure fossils 4. The Yellow Sandstone, rich in remains of *Holoptychius* and other fishes, and about 300 or 400 feet in thickness. This sandstone is seen to rest unconformably on the middle or Clashbinnie series of the Old Red at the northern opening of the Den, and at the southern end is unconformably overlaid by the carboniferous rocks. It is also exposed beneath the lower coal-series of Cults, the Lomonds, Binnarty, and the Cleish Hills. It is seen also in Western Scotland (Renfrewshire and Ayrshire), and also in Berwickshire and elsewhere in the south, with its Pterichthyan and Holoptychian fossils. In the author's opinion it is entirely distinct from the "Yellow Sandstone" of the Irish geologists.

At Dura Den the yellow sandstone in some spots teems with fossil fish, especially in one thin bed. In 1858 a remarkably fine *Holoptychius Andersoni* was met with; and this, with many other specimens, fully bears out Agassiz's conjectures for completing the form and details of the fish where his materials had been insufficient. Dr. Anderson also offered some remarks on the *Glyptopomus minor* (Agass.), the specimen of which was obtained from this locality; and he drew attention to two apparently as yet undescribed fishes also from Dura Den.

[Several specimens from Dura Den, and drawings, were exhibited by the author. And a collection of specimens from the Society's Museum, and a selection from the original drawings illustrating M. Agassiz's Monograph, were also exhibited.]

June 1st, 1859.—1. "On the Sinking for Coal at the Shireoaks Colliery, near Worksop, Notts." By J. Lancaster, Esq., and C. C. Wright, Esq., F.G.S.

In two shafts sunk for the Duke of Newcastle, on the north-west side of his estate of Worksop Manor, it was found that the Permian beds have a thickness of 166 ft.; the uppermost consisting of thin sandstones and marls (54 ft.); then hard yellow limestone (54 ft.), blue limestone and shale (20 ft.), blue shale (33 ft.), and soft gritstone, probably equivalent to the "Quicksand" of the north (5 ft.). Below the gritstone the coal-measures commence with 5 feet of blue shale, in which there are four bands of ironstone; another band, 15 inches thick, lies immediately below. This iron-ore is chiefly in the state of peroxide, gives an average of 42 per cent. of metallic iron, and promises to be of great economical value. The first seam of coal (2 feet thick, and of inferior quality) was cut at a depth of 88 yards. Four yards below this is a compact sandstone 66 feet thick. The sinking through this rock occupied 20 months; each pit made 500 gallons of water a minute, which was stopped in detail by cast-iron tubing. The pressure from the gas at the bottom of this thick rock was at times as high as 210 lbs. per square inch, but is now about 196 lbs. per square inch. Shales, with coal-seams and bands of ironstone, all thin or of inferior quality, were met with in the next 170 yards. At 346 yards the first thick coal was cut, and found to be 4 ft. 6 in. thick, and of good quality. This is considered to be the "Wathwood Coal." The "Top Hard Coal" was cut at a depth of 510 yards, and found to be 3 ft. 10 in. thick: the strata intervening between this and the "Wathwood Coal" were found to have much the same characters and thickness as they are known to have elsewhere. The sinkings were commenced in March, 1854, and perseveringly continued until their completion on February 1st, 1859. Altogether, 37 feet of coal were passed through; but only four seams are of workable thickness. The authors of this communication remark that the district appears to be remarkably free from faults, that the dip decreases considerably towards the east, and that the "Top Hard Coal" appears to thin out eastwardly.

[This paper was illustrated by carefully prepared sections (vertical and horizontal), and by specimens of the ironstones, &c.]

2. "Notes on the Geology of Southern Australia." By A. R. C. Selwyn, Esq., Director of the Geological Survey of Victoria. In a Letter to Sir R. I. Murchison, F.G.S.

Mr. Selwyn remarked that, as to the impoverishment of auriferous veins in depth, the only evidence of such being the case in Victoria is the great richness of the older drifts; for, judging from the large size of the nuggets sometimes found in the gravels, compared with that of the nuggets met with in the gold-bearing quartz-veins (usually from about ½ dwt. to ½ oz., though occasionally as much as 12 ozs. or even 13 lbs.), the upper portions of the veins, now ground down into [illegible] probably richer in gold (as formerly suggested) than the lower parts.

now remaining. As far as actual mining experience shows, some of the "quartz-reefs" in Victoria prove as rich in gold at a depth of 200, 230, and 400 feet, as at the surface; the yield, however, fluctuates at any depth yet reached. According to the author's latest observations, the gold-drifts, and their accompanying basaltic lavas, are of Pliocene and Post-pliocene age. Miocene beds occur at Corio Bay, Cape Otway coast, Murray basin, and Brighton; and Eocene beds on the east shore of Port Phillip, Muddy Creek, and Hamilton. Two silicified fossils (Echinoderm and Coral), thought by Prof. M'Coy to be of cretaceous origin, have been found in the gravel near Melbourne.

This letter also contains some remarks on the probability of some of the coal of Eastern Victoria being of "Carboniferous" age,—on the occurrence of Silurian fossils in the rocks of all the gold districts,—on the newly-discovered bone-cave at Gisborne, about twenty-five miles north of Melbourne,—and on the progress of the Geological Survey of the Colony.

[Portions of the Geological Survey Map of Victoria, lent by the Secretary of State for the Colonies, and specimens of gold, &c. lent by Prof. Tennant, F.G.S., were exhibited in illustration of this paper.]

[Fossils from Mayence, &c., presented by W. J. Hamilton, Esq., For. Sec. G. S., Fossil Trigoniæ from South Africa, presented by Capt. Harvey, R.E., and a series of Photolithographs of fossil foot-tracks from Connecticut, lent by Dr. Bowditch, were exhibited at this Meeting.]

June 15th, 1859.—1. "Notes on Spitzbergen." By J. Lamont, Esq. Communicated by Sir C. Lyell, V.P.G.S.

Mr. Lamont cruised about Spitzbergen in his yacht in the summer of 1858, and went up the Stour Fiord, which, he remarks, is a sound, dividing the island, not a gulf. The first thirty miles of coast along which he sailed on this Fiord consisted almost entirely of the faces of two or three enormous glaciers: the water is shallow, seldom as much as sixteen fathoms, and such appears to be the case all around Spitzbergen; and hence icebergs of very large size are not formed. The shores are mostly formed of a muddy flat, from half a mile to three miles broad, with ice or hard ground at from twelve to eighteen inches under the surface; this is intersected with muddy rivulets, and bears saxifrages, mosses, and lichens, on which the reindeer fattens. Protruding trap-rocks appear at many spots on these flats. A steep slope of mud, snow, and *débris* succeeds the flats, and reaches up to perpendicular crags of schistose rock, above which extend the great glaciers. Above these, peaks, probably of granite, appear when free of mist.

The upper part of the sound has much drift-wood, chiefly small pine-trees, weather-worn and water-logged, and some wreck-wood. Bones and skeletons of whales are numerous. Drift-wood and bones of whales were observed several miles inland, and high above high-water mark—at least thirty feet. Whales' skeletons were also seen high up on the Thousand Islands. These circumstances, connected with the fact that seal-fishers and whalers state their belief in the shallowing of these seas, lead the author to think that Spitzbergen and the adjacent islands are emerging from the sea at a rate even more rapid than that at which some parts of Norway have been shown to be rising.

2. "On the Formation of Gypsums and Dolomite." By T. S. Hunt, Esq., of the Geol. Surv. Canada. Communicated by Prof. A. C. Ramsay. F.G.S.

The points to which the author calls attention are, first, the formation of sulphate of lime and bicarbonate of magnesia by the action of bicarbonate of lime upon a solution of sulphate of magnesia, and their successive deposition in the forms of gypsum and hydrous carbonate of magnesia, during the process of evaporation; and, secondly, the direct union, under certain conditions, of this carbonate of magnesia with carbonate of lime to form a double carbonate, which is dolomite.

3. "On the Tertiary Deposits, associated with Trap-rocks, in the East Indies." By the Rev. S. Hislop. With Descriptions of the Shells by the Rev. S. Hislop; and of the Insects by A. Murray, Esq. (Communicated by the President.)

In the first place, the author brought forward additional proof to support his views, already given in the Society's Journal, of the probability of the amygdaloidal trap-rock found beneath the freshwater deposits at Nagpur being posterior in age to those beds and to the nodular trap-rock overlying them. Also, he again points out that these trap-rocks were erupted beneath the waters of a lake or lakes, of no great depth, in the Nagpur district; whilst towards the south-east, about the mouths of the Godavery, there were estuarine and marine deposits being formed.

The author formerly thought that the sandstone at Nagpur, underlying the lower trap and overlying the gneiss, was of Jurassic age, and once continuous with that of Korhadi, Mangali, &c.; but he now believes that it belongs to the Tertiary series. It contains abundance of silicified wood, and a few *Paludinæ*. This tertiary sandstone is metamorphosed into gneiss by the intrusion, apparently, of some deep-seated plutonic rock, evidenced by veins of pegmatite.

Some *minerals* from the trap, gneiss, &c. were then enumerated, especially the "Hunterite" and "Hislopite" lately discovered by Prof. Haughton.

The *Fossils* were next alluded to: namely, Fish-remains—some like the *Sphyrænodus* of the London Clay; also *Reptilian* remains, and bones of *Pachyderms*. The *Shells*, both freshwater (from the neighbourhood of Nagpur) and marine (from Rajamandri, near the mouth of the Godavery), were described by the author in detail. *Cyprides* are numerous; some have been described by Mr. Sowerby, and some new forms will be described by Mr. Jones. *Plant-remains* are abundant, but have not been yet described. Many remains of *Insects* occur; and, as far as Mr. Andrew Murray can form an opinion on them, they differ from recent species.

The author, after comparing the fossil shells of Nagpur with those of the Nummulitic fauna described by Viscount D'Archiac, and with the recent fauna of India, offered the conclusion that they are probably of Lower Eocene date. The nearest European analogue is found in the Physa-bed (*Physa gigantea*) at Rilly, in France.

These Tertiary deposits, with their pachydermatous remains, are decidedly (in the author's opinion) older than those of the Sewalik Hills, so well known from Cautley and Falconer's researches. There are yet newer deposits, with huge fossil bones (probably of Upper Pliocene age), on the banks of the Nerbudda and elsewhere.

Lastly, the author observed that the "diamond-sandstone" of India belongs to these Eocene deposits; and, *since its formation*, plutonic rocks have risen to the surface and rock-masses have been metamorphosed.

Shells from the freshwater strata of Nagpur and neighbouring parts of Central India (all, but three, new species)—Melania quadrilineata, *J. Sby.*; M. Hunteri; Paludina normalis; P. Deccanensis, *J. Sby.*; P. Wapsharei; P. acicularis; P. pyramis; P. subcylindraca; P. Sankeyi; P. Takliensis; P. soluta; P. conoides; P. Rawesi; P. Virapai; Valvata minima; V. unicarinifera; V. multicarinata; V. decollata; Succinea Nagpurensis; Limnæa oviformis; L. subfusiformis; L. attenuata; L. peracuminata; L. Spina; Physa Prinsepii, *J. Sby.*, *var.* elongata, *var.* inflata; Ph. Bradleyi; Unio Malcolmsoni; U. Hunteri; U. cardioides; U. mammillatus; U. imbricatus; U. Carteri.

Shells from the estuary strata near Rájámandri (all new species)—Pseudoliva elegans; Natica Stoddardi; Cerithium multiforme; C. subcylindraceum; C. Leithi; C. Stoddardi; Vicarya fusiformis; Turritella prælonga; Hydrobia Ellioti; Hemitoma? multiradiata; Ostrea Pangadiensis; Anomia Kateruensis; A. modiola; Perna meleagrinoides; Modiola, sp.; Corbis elliptica; Corbicula ingens; Cardita variabilis; Cytherea orbicularis; C. Wilsoni; C. Wapsharei; C. Rawesi; C. Jerdoni; C. elliptica; C. Hunteri; Tellina Woodwardi; Psammobia Jonesi; Corbula Oldhami; C. sulcifera.

Fossil Insects from the Tertiary strata near Nagpur—*Lomatus Hislopi*, nov.; and three other *Buprestidæ* (indefinable). *Meristos Hunteri*, nov.; and seven other *Curculionidæ* (indefinable).

[An extensive collection of fossils from Nagpur, including those collected by the late Dr. Malcolmson, were exhibited.]

NOTES AND QUERIES.

Geological Pearls.—"The inquiry in a late number of The Geologist, 'Have geologists ever found any fossil pearls among the oyster and other beds of fossil shells?' has induced me to forward the result of some investigations which I have very recently been carrying on, not originally with the expectation of discovering pearls, but, having observed in several instances bodies in chalk which I have thought fit to denominate 'pearls,' I will at once proceed to tell you the tale respecting them; premising that I am aware they are not the bodies which your correspondent 'Enquirer' is in search of.

"I have been employing and amusing myself by examining microscopically specimens of chalk from various localities. I followed the method of disintegrating the chalk, 'by scrubbing it with a nail-brush in water,' adopted by Mr. Lonsdale. The first specimen I examined was taken from a drifted mass of chalk lying upon the Kimmeridge Clay in a pit at Ely; on placing minute portions of it, moistened with water, in the field of my microscope, I observed, among the particles usually met with, a number of spheres of various magnitudes, such as I had never heard of before; the majority of them are perfect circles, having the appearance of slightly depressed spheres, their surface exhibits a slight degree of polish, and some are certainly subpellucid; such is the appearance of these bodies when viewed under a thin stratum of water, with transmitted light; but, if examined when dry, with reflected light, aided by the bull's-eye, they are opaque, with a subcrystalline, marbly surface; in short, when seen under water, they reminded me so of the 'urinary pearls' occasionally met with in the bladder of the horse, that I have been induced to term them 'geological pearls.' They are soluble in dilute hydrochloric acid. I have crushed them, with the desire of seeing if their internal structure be fibrous, as in 'urinary pearls,' but I have not at present succeeded in detecting that structure. It is probable that they may possess a central nucleus, inclosed in concentric laminæ, as in oolitic bodies. I am decidedly of opinion that the spherical is the characteristic form of these bodies, still I have seen some of an oviform, or pyriform, and, very rarely, a bilobed, form; if any may be said to be amorphous, those have a somewhat botryoidal surface.

"In the chalk from Cherry Hinton, near Cambridge, I found plenty of 'pearls,' and an abundance of Rotaliæ and Textulariæ. In a fragment of chalk-marl from Burwell, in Cambridgeshire, I did not detect any of the spherical bodies. Grey chalk from Whittington, near Stoke Ferry, in West Norfolk, a stratum of the lower chalk, contains an abundance of the 'pearls.' Foraminifera appeared to be not very numerous; but, as the portion of chalk examined was exceedingly minute, the proportion of these organisms cannot be accurately judged of. The chalk of Swaffham (medial chalk) furnished great plenty of 'pearls;' that also from Hitcham, in its vicinity, contains these 'pearls,' but not in such abundance as the chalk of Swaffham; in it I observed one of a pyriform shape, or rather oviform, with a stem to it.

"The Norwich Chalk (upper chalk) has about the same proportion of 'pearls' as the chalk from Hitcham, and an abundance of Foraminifera.

"Where they are most abundant, you meet with a regularly graduated series of these bodies, from the smallest to the largest; and by measurement I found the former $\frac{1}{1000}$ of an inch in diameter, the latter $\frac{1}{100}$, so that, if allowed to be those precious bodies, we must consider them 'seed-pearls' only. The above described bodies are very unlike Xanthidia.—C. B. Rose, F.G.S., Great Yarmouth."

The Chapter on Fossil Lightning.—"Dear Sir,—There is an error about Dr. Fiedler's Dresden specimen, at page 203, which is sure to be noticed, unless rectified in your next number. You have embodied a foot-note in the text, which makes it read that Dr. Fiedler's specimen was found on the confines of Holland by a shepherd, which was not the case. I merely noticed it as a fact of ocular demonstration of the formation of a fulgurite given in his work.—Yours, &c. George D. Gibb."

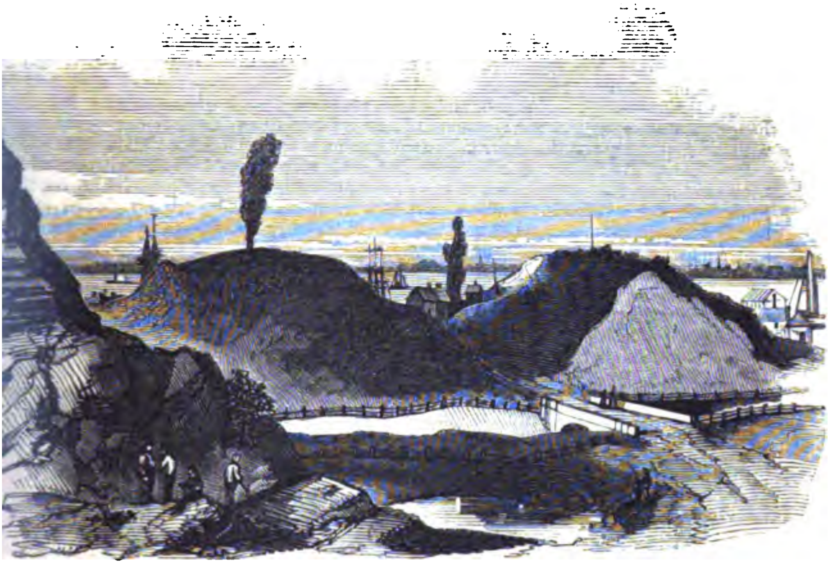
Geology of Wigton, Cumberland.—"Sir,—I shall be greatly obliged to any of your readers who can furnish me with information as to the geology of this neighbourhood, the varieties of fossils, and the localities in which they are most abundant.—I am, yours respectfully, Frank Dymond, Brookfield, near Wigton, Cumberland."

On a Pit-Section of Tertiary Strata at Woolwich.—By the Rev. T. G. Bonney, M.A., of Westminster.—"The following descriptions of a section of the lower tertiaries, at present exposed in a sandpit near Woolwich, may not be uninteresting to some of the readers of The Geologist. The pit is situated close to the road, between Charlton and Woolwich, and is divided by the railway. In fact, strictly speaking, there are two pits; one, the smaller, open to the road; the other, on the other side of the railway. It is of this latter that I intend chiefly to speak. When I visited it two years ago, it was then deserted, but now a considerable section has been exposed by working for sand. The section exposed is as follows:—the measurements are only approximate, as I had no instruments—(1.) Soil, containing many rounded pebbles, more especially in the lower part (2 ft.). (2.) Yellowish-grey sand, with irregular rust-coloured streaks (5 ft.). (3.) Sand and rolled pebbles. In this there are a few thin streaks or traces of shells (3 ft.). (4.) A mass of shells and rounded pebbles. The shells here are irregularly heaped together, as if by the action of the waves, just like a great shell-bank. Their quantity is so great that, at a short distance, the seam appears like a stratum of white rock. The shells are exceedingly brittle, and, consequently, it is difficult to procure good specimens, although the number to choose from is enormous. I found about ten or eleven species, among which were *Melania inequinata*, *Cerithina funatum*, *Melanopsis fusiformis*, *Natica*, *Neritia consobrica*, *N. globulus*, *Pectunculus*, *Cyrena*, &c. The pebbles in this seam are, perhaps, rather smaller than those above (2 ft.). (5.) A small band of grey and yellow sand (3 or 4 inches). (6.) Small pebbles, sand, and shells. The shells as before, but not quite so abundant. This stratum always formed a talus on the cliff (10 ft.). (7.) Bluish and dark clay (13 ft.). The last 7 feet composed of layers of different shades. The effect of this part, when seen from a little distance, is very curious. The great number of parallel laminæ of different shades look as though the face of the cliff had been ruled with differently shaded inks. Shells are plentiful in this, but very difficult to obtain perfect, there are not so many varieties, apparently, as above. The most plentiful are, *Melania inequinata* (large), *Cerithium funatum*, *Cyrena cordata*, and *C. cuneiformis*; the last very abundant, lying horizontally with the valves closed, as though they had been engulphed while alive, or immediately after death. Oyster-shells also occur, especially in a seam about 2 feet from the bottom of the bed. They are frequently of considerable size. and form conglomerated masses. (8.) Three seams of yellow sand, with thin clay partings. This sand, I am informed, is used for the moulds in casting brass (3 ft.). (9.) Grey sand, used in casting iron (12 ft.). Whitish sand, called the 'silver sand,' used in making pottery. This bed is of great thickness, not less, I should think, than 50 feet.

"The above section is made in a line nearly at right angles to the river, and the beds slope gradually upwards in that direction. In the other pit, by the roadside, the section parallel to the road, shows only beds 9, 10, 8, and perhaps part of 7. There also appears to be a small seam of pebbles separating 9 and 8; but with regard to these I cannot speak with certainty, as they were high up in the face of the cliff, and I had not time to make an accurate examination, indeed, I doubt whether it could be accomplished without some risk. In this place the chalk has been reached just below the level of the road.

"The beds exposed in some other parts of the pits are a good deal bent; in one place they appear to be bent over a projection of the white sand, which seems to have formed a sort of mound or shoal.

"I should mention that the pit is closed to the public, but that probably any sitor would be admitted, as I was, by the courtesy of the manager, Mr. Allen, Woolwich."



Tertiary Strata at Charlton Pit, near Woolwich.

The Flints of High Port.—By Mark Norman, of Ventnor.—"High Port is a local name, long ago given by fishermen and smugglers to a range of low cliffs, beginning a little distance from the Fisherman's Cottage, at the eastern extremity of the town of Ventnor, and ending in a headland called Whitestone Point, near Horseshoe Bay, below Bonchurch.

"The cliffs are composed of the *débris* of the different deposits constituting the upper portion of the cretaceous series, or rather the harder portion of such, as there is no evidence of the presence of the upper white chalk, except its flints imbedded in compact masses in the stiff clays formed by the decomposition of the chalk, and which in some places resembles pipe-clay. This is extremely tenacious, of a dullish-white colour, and holds the flints so well together that they form in many spots the entire face of the cliff, from which they are with difficulty extracted by the hand; but the sea encroaching at the base of the cliffs undermines and washes them out, and then they are drifted along the shore, and such as contain fossil shells, &c., fall to the share of the collector, while those that contain sponges are eagerly sought for by the visitor for the purpose of being converted into brooches, bracelets, &c. The sponges and zoophytes will be enumerated in the sequel.

"The best flints for the collector to break in searching for fossils are round flattened boulders, varying in size from one to two or three feet in circumference, of a light-reddish colour, and smooth on the outside; they break with a ring like earthenware, are of a white or cream colour, and many of them contain cavities filled with a whitish powder, much resembling pulverized chalk to the sight, but to the touch it is gritty and does not readily leave traces on the fingers as chalk would do.

"These flints contain splendid fossils, and it was from this class that the alveolus of a Belemnitella, figured in p. 317, of Mantell's 'Excursions round the Isle of Wight,' was obtained by my friend and brother collector, Matthew Hale. The external shell of the Belemnitella is always wanting, but the cast of it remains in the shape of a circular cavity, having the peak of the alveolus or phragmacone at the bottom. Those fossils are extremely rare, and when found, great care should be taken not to make too free use of the hammer, or the delicate point of the fossil is sure to fly off. I have always found that the best and safest course to pursue is to break off the flint, in a large lump, that contains the specimen, and submit it to the lapidary's wheel, which is certain to be attended with success in the hands of such a skilful workman as my friend Mr. John Billings, of Ventnor, who developed for Mr. Beckles the figured specimen to which I have alluded.

"Spines of the Cidaris also occur in the same state, with this difference, that they only leave the impressions of their fluted sides in a little round hole in the flint. The *Galerites ovata* is also found in a beautiful state of preservation, with its rows of slender spines ranged in triple lines across the cast of the shell, as fine and small as the points of a needle, and extending from the oval to the anal aperture. Casts of Rhynchonellæ are also found in as perfect a state. These, with the different species of Echinus that occur in the upper chalk, are amongst some of the most prominent that are met with. In addition to the white flint fossils may be added those of the grey and black flints, which are imbedded in a stiff red clay, a large mass of which occurs on both sides of the Point, about sixty paces from the Fisherman's Cottage, towards Bonchurch, interspersed with large blocks of grey chalk containing few fossils. There is an outlier of the lowermost portion of the white chalk, containing a few small flints at intervals, with an abundance of a small species of Inoceramus, associated with *Rhynchonella plicatilis* and fragments of comminuted shells, Bryozoa, sponges, spines of Cidarites, &c. Blocks of the white chalk, intermingled with masses of the upper greensand are scattered along the shore until we arrive at White Stone Point, near Horseshoe Bay, which is almost wholly composed of chalk-rubble, in blocks from the size of a small cottage to pieces of six inches square, comprising representatives of every layer of both the lower and middle chalk (but none of the upper); the larger blocks consist chiefly of the lower or grey chalk, many of which contain good specimens of Siphonia with other fossils, such as Ammonites, Turrellites, Scaphites, &c., much distorted by pressure. Further on we come to Horseshoe Bay, an indentation of the shore caused by a large mass of Gault intervening between two headlands of chalk ruins. The easternmost headland is capped with drift, in which some workmen, a short time back, discovered a portion of the skull of an elephant, with a few teeth of some other animal, and the jaw-bone of a young whale. The flints are scattered also along the shore from thence to Sandown, and a little farther to the eastward we come upon the lower green-sand, at Monk's Bay, just below the old church of Bonchurch, built by the monks of Lyra, in the year 755, and in which bay they landed after having bravely crossed the channel from Normandy, and preached to the islanders the truth which St. Boniface had attested with his blood; it is a curious circumstance that those monks should land and choose one of the loveliest spots in creation for their future residence.

"*Fossils from the Flints.*

"*Choanites*, three or four varieties.—The mass of the Choanite often presents the appearance, when cut by the lapidary into slices, of moss, hence they are often termed 'moss-agates.' Many of these from this neighbourhood exhibit splendid colours, caused by the infiltration of iron, which contrast with the bluish tinge of the chalcedony between the ferruginous bands. When they exhibit this appearance, they are called 'landscape-agates,' and are much sought after for brooch-stones by visitors, being preferred for their beauty to the far-famed Brighton-pebbles, in which the oxide of iron predominates so much as to render the darker portions black, instead of red, blue, and yellow, like those of this neighbourhood.

"*Ventriculites*, several varieties.

"*Clionæ*.—The shells of the larger Inocerami were subject to the ravages of a parasitical sponge, which destroyed the intermediate substance, leaving the outer and inner plates entire, and supported only by thin partitions. Specimens exhibiting these appearances are full of small oblong cells, connected by linear perforations, which are either empty or filled with chalk or flint; in the latter case they give rise to a curious class of fossils, the nature of which the late Rev. Mr. Conybeare has given an ingenious explanation in the second volume of the 'Geological Transactions.' These fossils being the siliceous casts of such excavated cells.

"*Sponges*, many varieties (branched, conical, and round).—Elongated pieces of smooth round flint often occur, having a cavity filled with another flint, corresponding to the cavity, which on breaking is found to be white and enamelled on the outside. Many such occur, having thus a flint within a flint-sheath. Splendid specimens of mammilated chalcedony are sometimes found in the hollows left by decomposed sponges in flints. The writer once saw a specimen about nine inches by six, with the mammillæ of the size of large grapes, and of a beautiful blue colour. This mammillation is the cause of the chalcedony, occasionally, in the landscape-agates assuming, when cut and polished, a hammered appearance, like the marks left by the workmen on copper, and is from that cause vulgarly called 'hammered chalcedony.'

"*Foraminifera.*—By means of a small lens I have been enabled to detect several species. *Lituola Nautiloidea*, and *Placopsilina irregularis*, are the most prominent, and can often be detected with the naked eye.

"*Micraster cor-anguinum*, *Ananchytes ovatus*, *Galerites albogalerus*, *Cidarites* (several varieties), *Marsupites* (plates of), *Eschara disticha*, *Rhynchonella octoplicata*, *R. subplicata*, *Terebratula semiglobosa*, *T. subrotunda*, *T. carnea*, *Magas pumilus*, *Ostrea vescicularis* (and other species), *Pecten quinque-costatus*, *Inoceramus Lamarckii* (and other species), *Plagiostoma Hoperii*, *Spondylus spinosum.*—These last are generally found on the outside of the flints, in a remarkable state of preservation; they are also found, although less often, in the body of the flint.

"*Arca* (species of), *Belemnites.*—Casts of two or three varieties of the latter are found, but in most cases nothing is left of the body of the fossils but a hollow tube-like cavity, with the cast of the phragmacone."

Encrinites and Crinoids.—"Dear Sir,—Will you kindly inform me if the Encrinite be a species of Crinoid? My reason for asking is, that M'Causland, in his 'Sermons in Stones,' fourth edition, p. 51, states that the Encrinite 'is a species of Starfish fixed on the top of a flexible stalk, rising from and fastened to the bottom of the water;' and in the first number of The Geologist I find under the head of 'Woodocrinus,' a description of its stem as being 'invariably tapering,' so that the longer it is the thinner it becomes. This circumstance would lead us to imagine, that the creature floated freely in the water, and that the stems were used to balance it, and keep it upright while it floated. Should this fact be established, it will place this genus between the free Comatula and the fixed Crinoid. The Comatula here mentioned as 'free,' is noticed in M'Causland's work as 'the existing representative,' with the *Pentacrinus Caput-Medusæ*, of the primeval Encrinite.—I am, Sir, yours truly, M. C. H."—Crinoids, or Crinoidea, is a general family name for the many genera of Encrinites, Actinocrinites, Pentacrinites, Apiocrinites, &c. The generic name of Encrinites is sometimes loosely used for the same purpose, having been the word adopted by old naturalists for these creatures. But the generic name *Encrinus* having been restricted in modern nomenclature to the Brunswick Encrinite, the word Crinoidea is better adapted as a general family term. Still Crinoid and Encrinite are used by authors indifferently. Both our correspondent and M'Causland (as quoted) use the word "species" in a loose sense for "kind." Most Crinoids were fixed by roots at the end of their stems, but the Woodocrinus appears to have been one of the exceptions, and seems to have been destitute of them. It might possibly have floated, but more likely it grovelled in the mud or sand, or lolled on the coral banks.

Frogs in solid Stone and in Trees; living Spiders in Flint.—"Dear Sir,—Sometimes, in regarding one special class of facts, we are apt to overlook others of a similar nature, from which much knowledge may be gained. In referring to vol. xxxix. of the 'Gentleman's Magazine' (1769) for another purpose this morning, I came across the following extract in a review of Pennant's British Zoology, then just published, with some remarks of Mr. How; which passages, I think, have a valuable bearing on the questions raised by some of your correspondents about live toads and frogs in solid stone; as the existence of such batrachians, inclosed in the solid wood of trees, tends to strengthen your valuable arguments of the recent development of those animals in such situations.—Yours truly, F. S. A."—"To conclude the account (of the toad) with the marvellous, the animal is said to have often been found in the midst of solid rocks, and even in the centre of growing trees, imprisoned in a small hollow, to which there was not the least adit or entrance; how the animal breathed, or how it subsisted (supposing the possibility of its confinement), is past our comprehension. Plot's solution of this phenomenon is far from satisfactory; yet, as we have the great Bacon's authority for the fact, we do not entirely deny our assent to it. Besides Plot's and Bacon's authority we can quote another for this fact, viz. Bradley in his 'Philosophical Account of the Works of Nature,' p. 164, where he says, 'We have instances of toads that have been found in small cavities in the midst of large blocks of hard stone.' And I was once eye-witness of a toad which was sawed out of the centre or heart of the trunk of a large oak. At Catsgrove, near Reading, a spider was found in the middle of a solid flint. It was alive, but died instantly on being exposed to the air. The cavity in which it was inclosed was as smooth as if polished, of an oval shape, about three-fourths of an inch in length and about half an inch over.—D. H."

REVIEWS.

Geological Map of Central Europe, compiled from the newest materials. By H. Bach.

(*Geologische Karte von Central Europe nach dem neuesten Materialen bearbeitet.* Von Heinrich Bach.) Stuttgart: E. Schweizerbach. London: Williams and Norgate. 1859.

This is a very good chromo-lithographed map, 25 by 21 inches in size. It includes the greater part of England and Wales (as high up as Newcastle, and as far westwardly as Whitehaven and Portland), and it reaches to Seeland and Bernholm on the North of Europe; to Dantzic, Cracow, and the Carpathians, on the East; to Perugia, Toulon, and the Pyrenees, on the South; and takes in Deux, Bordeaux, Nantes, and St. Malo, in its western border. The tertiary areas of London, Hants, Paris, Brussels, Bordeaux, Switzerland, and Vienna are recognised at a glance, and readily show their relation to the later Tertiaries of North Germany, Northern Italy, &c. on the one hand, and to the Secondary rocks on the other. So also the Jurassic area (after Oppel) and the older formations, are clearly seen in their geological and physical relations to the other rocks, and to the present geography of England and Europe. The Gneissic plateau of Central France, and the porphyritic areas of Thuringia and Bohemia, also stand well out, without interfering too strongly with the other colours. With the explanation of the colours, are succinct German, French, and English tables of the strata, so that this map will be available in the hands of any one wanting a good general geological map of Central Europe, portable, and of moderate price.

THE GEOLOGIST.

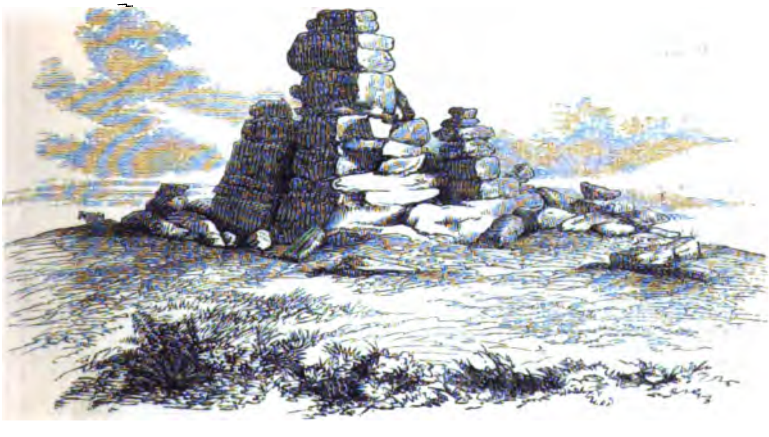
AUGUST, 1859.

SKETCHES FROM NOTE-BOOKS.

No. 1.—NOTE ON SOME GRANITE-TORS.

By T. Rupert Jones, F.G.S.

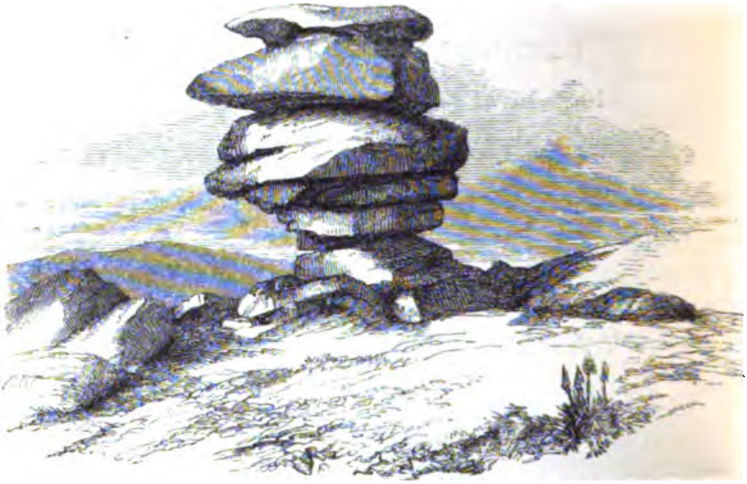
Many of the common things that occur to us in our walks and rides near home, and which occasionally are noted in our memorandum-books on account of the clearness of their features, or for the sake of some occasional peculiarities in the details observable in them, may not only often prove as useful exemplifications of natural processes and phenomena as facts and instances brought from any distant part of the world, but may bear repeated description and



Lign. 1.—Vixen Tor, Dartmoor, Devonshire.

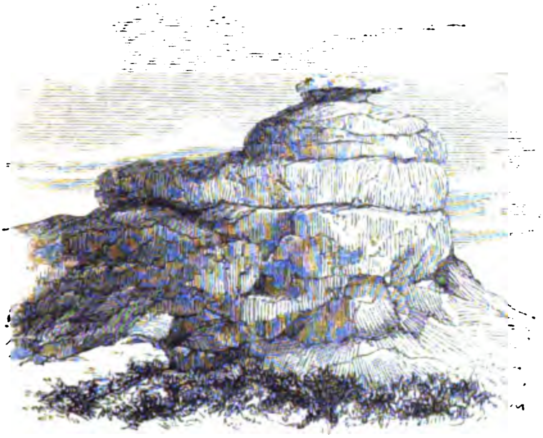
fresh demonstration for the sake of geological enquirers, such as many of the correspondents of THE GEOLOGIST must necessarily be.

I here propose to offer a note on some of the results of weathering on granite-rocks. My note-book of last year contains one or two sketches illustrating that subject, and reminding me of much that has been written by others about it.

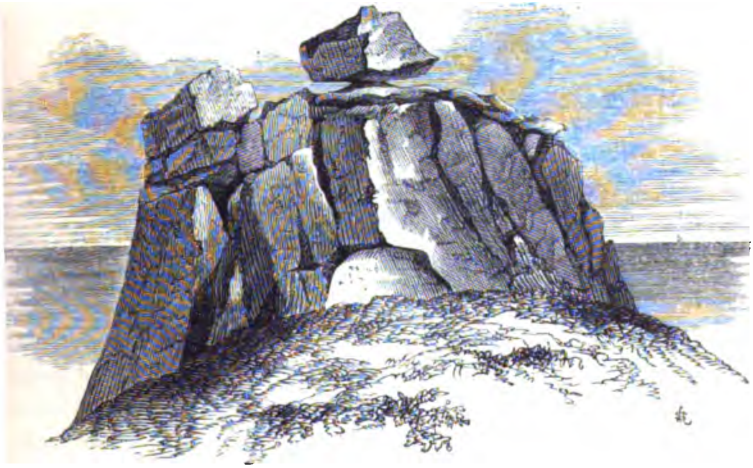


Lign. 2.—The Cheesewring, near Liskierd, Cornwall.

In granitic regions we often find the surface of the countries distinguished by peaks and crags; irregularly prominent masses of rudely-heaped rock-fragments, forming "tors;" more regularly piled isolated heaps or pillars, such as "cheesewrings;" and sometimes a peak or pile surmounted by a single, moveable, and well-poised mass, constituting a rocking or logging stone. Figs. 1, 2, and 4, which illustrate these three forms that weathered granite-rock presents, are copied from the plates illustrating Dr. M'Culloch's memoir on the granite-tors of Cornwall, in vol. ii. of the Transactions of the Geological Society, 1848. In this memoir much valuable information will be found; and the difficulties of the sub-



Lign. 3.—Haytor, Dartmoor, Devon.

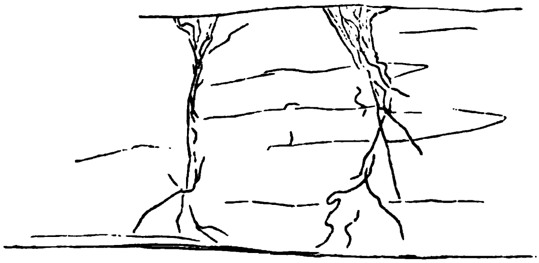


Lign. 4.—The Logging Stone, St. Levins, Cornwall.

ject are also well brought out to view, and exposed for solution by subsequent observers. Not much, however, has been done since the date of that memoir. Mr. Ormerod's communication on the Rock-basins of Dartmoor, in the Geological Society's Journal, 1858, vol. xiv., p. 16, &c., contains a *résumé* of our present knowledge on the subject, and to this we shall presently recur. Fig. 5 represents one of the Dartmoor tors, the granitic boss known as Blackistone; and fig. 3 is a sketch of Haytor (eastern side), also in Dartmoor. The latter is from my note-book; and, in connection with some appearances on the faces of the granite-quarries on the lower ground to the westward, offers an interesting illustration of the method of the formation of "tors," "cheesewrings," and "logging stones."

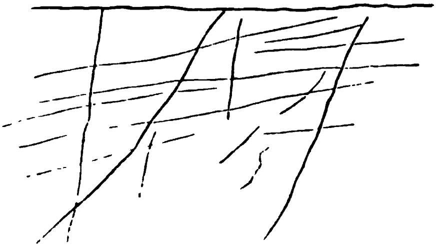
Lign. 5.—Blackistone, Dartmoor.

A few hundred yards below Haytor is an old quarry, the smooth faces of which are formed of the joint-planes of the granite. These faces show many of the cross-joints; and on the eastern face the north-and-south perpendicular joints are plainly seen here and there to be the channels by which the rain and frost are working their way into the rock, producing innumerable minute cracks close to and mostly parallel with the great fissures (fig. 6). This is especially the case beneath the surface-soil, where the joints are enlarged into a compo [illegible] of cracks, minutely cutting up the stone into ose splinters and sand. In some instances, in the quarry and on e neighbouring banks, this sand, or decomposed granite, has fallen t and is scattered down the slopes in thick beds, forming the granit pourri" of continental geologists. This substance covers vast areas in some granitic regions, and is used for the purposes to which sand and gravel are applied in tertiary and alluvial districts. In this old quarry the horizontal joints of the granite are less widened than are the perpendicular joints by atmospheric causes acting on their bounding planes.



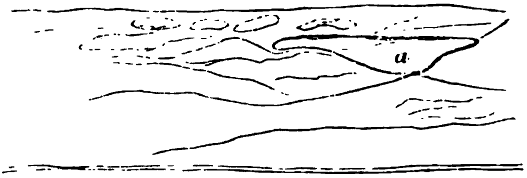
Lign. 6.—Joints in Granite, Eastern Face of Old Quarry, below Haytor.

In another quarry, on still lower ground, and but little further to the west (from which the granite was chiefly obtained for building London Bridge), the vertical and horizontal joints are again well seen on the smooth sides of the pit. Fig. 7 shows the eastern face. Here the joints are all closed, and their sides are nearly unaffected by change, except some alteration in the colour of the stone along their lines. At one spot, shown in



Lign. 7.—Eastern Face of New Quarry, Haytor.

fig. 8, just beneath the surface of the ground, it can, however, be distinctly seen that some change is going on, because the joint-lines are rather more distinctly visible and the horizontal lines more numerous; and here we may observe (standing on the bank of the lower quarry, with the eastern or upper face of the older quarry in view, and the prominent mass of Haytor still higher up and further off) a teaching series of appearances in the granite. In the face of the newest quarry we see the joints in their natural condition, almost unaffected by the percolation of surface-waters, and by exposure to weather for the last thirty or forty years; but in one small portion of this face already alluded to, may be traced in outline the sectional areas of several flattish blocks of granite (fig. 8), of various dimensions, bounded by joint-lines, and which would be in the course of time, if exposed to adequate agencies, separated one from the other by the removal of the intervening softer part of the rock, and would either be tumbled down by force of gravity, or would remain piled up more or less regularly one upon another (if the destruction of the rock took place in the air without the intervention of the sea or rivers). There is one such mass, marked out by the intersection of oblique joints (indicated by *a* in fig. 8) which might possibly weather away into a sufficiently symmetrical form as to remain poised on the underlying hump-backed mass of rock which is so bounded by joints as to promise to withstand the destructive action of wind and weather, should ever time bring about such changes of the surface as would lead to the modification of the Dartmoor district and expose it to the erosive action of air and water in those long continued processes which have in former times cut out and left the uprising mass of Haytor on the hill above (fig. 3):—and the slow, but possibly not



Lign. 8.—Portion of Eastern Face, New Quarry, Haytor.

eaker, action of these processes we see already producing effect on e exposed granite-faces of the old quarry at its foot (fig. 6).

Granite (like other rocks of igneous origin, and like many of queous formation also) is always cut through by joints or fissures ore or less regularly, and these have probably originated in the ontraction of the rocky mass whilst cooling. The rain-water trickles hrough these lines of joints, decomposes the granite along the racks, widening them and rounding off the angles of their interections, and ultimately only the harder masses, or the hearts of the blocks defined by the joints, remain as solid crystalline granite, some, though little, of the quartz of the granite is dissolved away by the water; the iron becomes oxydized and weakens the rock; but it is chiefly the felspar that is decomposed by the action of carbonic acid, its alkalies are removed, and its residue is washed away in the form of white clay, the material so useful to porcelain-manufacturers, and prepared artificially to a large extent from felspar-rocks. The quartz-crystals remain as sand; the mica also remains, but is less observable, and is partially decomposed.

Prof. J. Phillips has the following pertinent remarks on the waste of felspathic rocks (Manual of Geology, new edit., 1855, p. 468):—

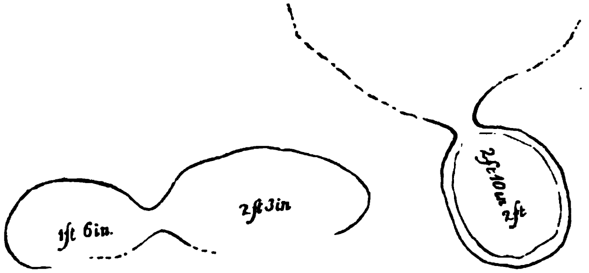
"The exterior of most uncrystalline rocks and buildings seem to be slowly eaten away by the moisture and carbonic acid of the air; but the influence of this destructive agent is most remarkable among the felspathic rocks; whether, like granite, they are originally crystalline, or, like millstone-grit, composed of fragmented masses. The felspathic portion of the hypersthene-rocks of Carrock Fell is so wasted that the crystals of hypersthene and magnetic iron are projected from the surface considerably. Some greenstone-dykes are thus entirely decomposed to great depths from the surface, and whole rocks of granite, secretly rotten, wait only for an earthquake or water-spout to be entirely reduced to fragments. Those who have seen the crumbled granite of Muncaster Fell in Cumberland, or Castle Abhol in Arran, surrounded by heaps of its disintegrated ingredients, must have been struck by the importance of this phenomenon in reasonings concerning the origin of many stratified rocks."

Where granitic or other felspathic rocks form mountain-masses, they have often been shattered in the elevation of the region; and this condition, aided by their partial destruction by the atmosphere, has led to the formation of those rugged fields of loose irregular angular blocks and masses, picturesque in their desolation, which Von Buch has termed the "Felsen-Meere" or "seas of rocks." Between these gigantic fragments and the sand of the "granit pourri" is a wide difference as to appearance; but the peculiar jointings of the rock and the rottenness of the felspar lead alike to these two conditions of granite rock. The "granit pourri," consisting of quartz-grains and half destroyed crystals of felspar, with or without minute flakes of mica, when cemented with silex, which has been dissolved by water and re-arranged among the sandy materials, becomes "arkose," and frequently resembles real granite so closely that only a practised eye can recognize the difference.

Igneous rocks, such as basalt and some trappean rocks, frequently harden into nodular masses having a concentric structure; and when these concretions have pressed closely upon each other in the process of cooling, a prismatic or columnar structure has been formed in the rock. Sometimes this concretionary structure is only visible when the mass of trap is decomposing, or when the prisms are broken. So also in granite and some allied forms of rock, we have occasionally a nodular structure. This is seen, in the same way, in the so-called "Corsican granite" or "Neapolonite"; and small globular lumps are not uncommon in the granite of Dartmoor. But some great granite-masses weather into curved laminæ of rock, showing indications of concretionary form on the large scale (see fig. 5). Indeed the rounding off of the angles of the great horizontal slabs forming Haytor (fig. 3), and the "Cheesewring" (fig. 2) seem to point to the fact that nearly every mass or block limited by the intersecting joints in granite may be regarded as having a nucleus of its own, or a central point within it from whence the crystallization began on cooling, and that the corners of those blocks would the most readily exfoliate on account of their being most independent of the hardening influence of such concentric crystallization.

By way of comparison with and in illustration of the granite of Dartmoor and Cornwall, some of the features of which are shown in the accompanying figures, I will quote Prof. W. Macgillivray's description of a part of Scotland:—

"In the upper part of Aberdeenshire I have observed that the granitic mountains are very remarkable for their extreme sterility and the desolate aspect that they present. The summits are rounded, sometimes nearly flat, to a great extent, and entirely covered by disintegrating blocks and stones, together with gravel and sand. Some of them present protuberances, consisting of granite much decomposed, forming tabular masses, intersected perpendicularly by fissures, and evidently portions of the mass of the mountain, which have either originally protruded beyond the surface, or have resisted disintegration. Most of the mountains exhibit perpendicular precipices near the summit, which generally assumes the circular form, constituting the hollows named "corries," and having a lake at their base. The rock near the surface, wherever it is exposed, has split into tabular masses, generally pretty regular, and exhibiting the appearance of strata, intersected by rectangular fissures. The true nature of these tables, however, is really understood on examining the precipices, where they are best seen, and where, notwithstanding, the perpendicular fissures more resemble the seams of strata. There is no tendency in any part to the concentric or globular arrangement, nor do the masses in decomposing ever present that appearance."—Manual of Geology, 2nd edit., 1844, p. 116.



Lign. 9.—Outlines of Rock-basins on Haytor.

An interesting feature observed in a large portion of the Dartmoor district is the occurrence of rock-basins, or shallow hollows on exposed surfaces of the granite, often on the summit of the "tors." These are of natural formation, according to Dr. M'Culloch and Mr.

Ormerod, who have treated of these phenomena in the paper already referred to. On the top of Haytor there are traces of two or more of these shallow basins (fig. 9). They are enumerated by Mr. Ormerod in his Table of Tors and Rock-basins, *op. cit.*, p. 25. We cannot do better than quote at length some of Mr. Ormerod's observations on the formation of rock-basins, whence the reader may learn much respecting the physical character of the Dartmoor granite.

"Sir Henry de la Beche in a note on the 'Report on Cornwall, Devon, and West Somerset' (p. 452), writes:—'Dr. M'Culloch has suggested that the friction of the quartz and felspar-fragments not unfrequently found in rock-basins may have contributed to deepen them. As we have often observed these fragments in motion during high winds, both when the basins were dry, or a small quantity of water in them, we are inclined to believe that this may the case.' The fragments occur in most basins; in some, the bottom is covered by them. Rolled stones similar to those which occur in the 'pot-holes' have not been found by Mr. Ormerod in any basin, but the contents generally consist of small *angular* fragments of quartz and felspar, and schorl, which sometimes cover the bottom of the basin. Small lumps of granite occasionally are found, not rolled, but that have apparently fallen in where the sides are much weathered and falling to decay. Although in the habit of inspecting the basins in every state of the weather, from the mildest breeze to the heaviest storm, Mr. Ormerod had never seen these particles blown about in the water in the basins having the bottoms flat and sides upright, and had only seen them moved in shallow concave basins when dry, or when a heavy gale had blown them out together with the water. The cause suggested by Dr. M'Culloch could not affect the deep basins, as in those cases the particles would be undisturbed by motion of the water from wind. These small fragments, however, throw some light on the manner of the formation of the rock-basins. The granite of the Dartmoor district is in a great measure porphyritic; it is for the most part of a large coarse grain, and schorl in variable proportions frequently occurs; globular nodules, varying from an inch to upwards of a foot in diameter, often occur. These vary much; sometimes they are harder than the adjoining rock, sometimes scarcely coherent, and, on exposure to the weather, soon falling away. Along the belt where the basins exist, the granite is for the most part more liable to decomposition than at the harder and more crystalline tors. This is shown by the many rounded tors, and every roadside-cutting shows the rapidity of the decay. The division of the granite into tabular sheets of rock of irregular thickness, causing the appearance of stratification, is common to all the granite of this district. In irregularities on the surface of the granite, and in hollows, very probably in many cases caused by the nodules above noticed, water lodges on and penetrates into the porous granite, and the decay thus commenced will gradually enlarge the cavity to a basin. During the inclement part of the year these basins are full of water, that during part of the time often rapidly alternates with ice. When the warm weather comes on, the water evaporates, and the basins are dried up; from the frequent showers there is, then, a constant change between the rock being saturated with wet and it being warm and dry. The gradual action of the water is very perceptible; when it has evaporated, the stone up to the water-line is left a lighter shade than the adjoining rock; the felspar-crystals instead of presenting their usual appearance, are dull and full of minute cracks, and appear as if about to fall into small fragments similar to those found in the basins; the action of the water is evident to the eye though not easily described. An unbroken face of granite resists the weather more powerfully than the rock does when it is broken or penetrated; in those cases the water soaks into the granite, and thus renders it more easily acted upon by the alternations of heat and cold, wet and dryness. Such action when once commenced will continue until checked by the unbroken face of a parting which will limit the extension either perpendicularly or horizontally. The tabular formation of the granite is probably the cause of the frequent occurrence of the basins with flat bottoms. The gradual decay thus acting from a centre will cause the nearly circular and oval forms that so many of the basins present, the variation from that shape being probably caused by a difference in the structure of the granite. The eye will in a short period discriminate between the tors where basins would probably be found or not. Firstly, where it is the character of the tor to have the perpendicular joints clearly developed, the angles where exposed being only slightly weathered, and the horizontal beds, if thick, standing out with well-defined edges and ends; if thin, with sharp projecting edges, giving to the side a serrated appearance, rock-basins are scarcely ever found. When, on the contrary, the tor is rounded, the sides sloping or smooth, projecting beds not frequent or bold, and such beds as do project for the most part rounded at the edges, rock-basins will very frequently be found. For the above reasons Mr. Ormerod considers that in this district the rock-basins were caused by atmospheric action, that power working gently but surely upon the rock, and equally forming every description of basin, be it large or small, deep or shallow; this he considers the rotation of pebbles could not do.

The direction of the longest diameter is in nearly one-third of the cases from north to south, and in all but five out of the thirty-five cases is from the north-westerly to the south-easterly quarter: the cause of this Mr. Ormerod has not been able to discover. Although the direction of the longest diameters is in the greater number of instances towards the points, between which the perpendicular joints of the granite of Dartmoor generally range, he has not found that there was any connexion between them, the direction of the longest diameters rarely corresponding with that of either the main or cross joints on the same tors; neither do the directions of the basins on the same tor always agree. The most violent storms on Dartmoor come from between west and south-west; although occasionally heavy gales occur from the south-east, the winds from between the south and east are generally mild, and those between the north and north-west are not of frequent occurrence. The direction, therefore, of the longest diameter cannot be assigned to the action of the strongest or most prevalent winds."—Quarterly Journal Geol. Soc., vol. xiv., pages 22, 23.

GEMS FROM PRIVATE COLLECTIONS.

SPIRIFERA CONVOLUTA.

(*From the Carboniferous Limestone of Thorneley. In the collection of* J. ROFE, ESQ., F.G.S.)

BY THOMAS DAVIDSON, ESQ., F.R.S., F.G.S., ETC.

SINCE some pages of your valuable magazine are occasionally devoted to the description and illustration of "Gems from Private Collections," allow me to offer a drawing and some observations on *Spirifera convoluta*, Phillips, one of the most remarkable of our British carboniferous spirifers, and which will serve at the same time as a small supplement to the paper I published in the eleventh number of THE GEOLOGIST.

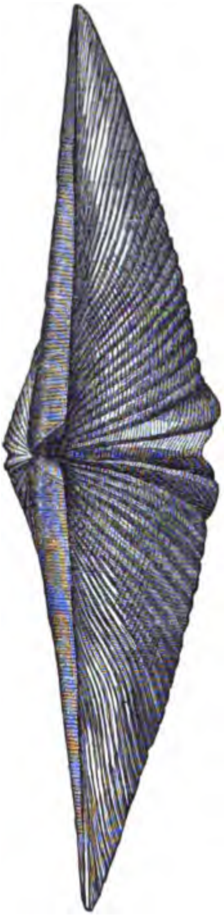
At page 35 of my "Monograph" I described *Sp. convoluta* as a distinct species, but subsequently I thought that it might, perhaps, be a very transverse or exceptional condition or variety of *Sp. bisulcata*, Sowerby.

Experience teaches us that individuals of the same species may assume great differences in shape; that a *Spirifera*, for example, which in its normal condition is about as wide as long, may at times exceed these proportions very considerably in one or the other direction, and that we are often too prone to seize upon similar variations as pretexts for the creation of so termed species.

Spirifera bisulcata is one of these variable species which, in its usual condition, presents a somewhat semi-circular or sub-rhomboidal shape, rather wider than long, with its valves almost equally convex or deep; the hinge-line is straight, and either shorter or as long as the greatest width of the shell; when shorter, its angles are rounded; and when otherwise, they project at times to a considerable extent, with angular terminations. The area is of moderate height, and the beak sometimes so much incurved as almost to touch the umbone of the opposite valve. Each valve is ornamented by from twenty to forty ribs, which vary in width and degree of projection in different specimens: in some they are rounded and flattened, while in others they are sharply angular; the sinus is of moderate depth, and the mesial fold rounded and generally divided into three principal portions by two deep sulci; but each of these are in their turn more or less subdivided into two or more ribs of lesser projection. The whole surface of the shell in well-preserved specimens is also covered with close concentric lines of growth, which gives to the surface a kind of imbricated appearance.

Such are the characters of Sowerby's type; but it appears to have varied considerably in different localities, and Professor de Koninck is of opinion that his own *Sp. crassa* and M. Coy's *Sp. grandicosta* are probably nothing more than well-marked varieties of Sowerby's species.

Spirifera convoluta is a very rare shell in England and Belgium, and the principal object of this note is to present to the reader a correct drawing of the only perfect example that has been, to my knowledge, hitherto discovered in Great Britain, and which was kindly lent to me by its possessor, J. Rofe, Esq., who found it in the carboniferous limestone of Thorneley, near Chipping, about ten miles north-east of Preston, Lancashire. This unique example measures in length *11 lines*, in width 57, and in depth 12 lines; and another imperfect specimen (which the discoverer has liberally added to my collection) must when complete have possessed almost similar proportions.



SPIRIFERA CONVOLUTA, PHILLIPS.—From the Carboniferous Limestone of Thorneley. In the collection of J. Rofe, Esq.

Professor de Koninck's decided opinion is that *Sp. convoluta* differs specifically from *Sp. bisulcata*, and he entirely agrees in this with the celebrated author of the "Geology of Yorkshire;" and it must be admitted that a glance at the two shells is sufficient to impress one with the peculiar fusiform shape presented by Phillips's species, which somewhat resembles a weaver's spindle. I am therefore disposed to waive the misgivings expressed, and to leave the matter as stated at page 35 of my "Monograph."

To the French translation of my paper published in the eleventh number of THE GEOLOGIST, in the present year's volume of the "Transactions of the Royal Society of Sciences of Liége," Professor de Koninck has added some very valuable notes, in order to place in comparison with my British list of carboniferous species possessed of calcified spiral supports, those which for many years prior to 1843, and subsequently, had been discovered by him in the corresponding Belgian strata. The analysis of these two catalogues will show that out of forty-three species which I enumerate as British, thirty-five occur in Belgium, viz., *Spirifera striata*, *S. Mosquensis*, *S. humerosa*, *S. duplicicosta*, *S. crassa*, *S. bisulcata*, *S. grandicostata*, *S. trigonalis*, *S. convoluta*, *S. triangularis*, *S. mesogonia*, *S. laminosa*, *S. distans*, *S. cuspidata*, *S. pinguis*, *S. ovalis*, *S. planata*, *S. integricosta*, *S. triradialis*, *S. rhomboidea*, *S. lineata*, *S. Urii*, *S. glabra*, *S. octoplicata*, *S. insculpta*; *Cyrtina septosa*; *Athyris planosulcata*, *A. lamellosa*, *A. Roysii*, *A. squamosa*, *A. globularis*, *A. ambigua*, *A. subtilita*; *Retzia radialis*, *R. ulotrix*; and that Belgium possesses ten or eleven species which do not occur or have not hitherto been discovered in our British isles, namely, *Spirifera pectinoidea*, de Kon.; *Sp. ornata*, de Kon.; *Sp. Fischeriana*, de Kon.; *Sp. acuticostata*, de Kon.; *Sp. Roemeriana*, de Kon.; *Sp. Schnuriana*, de Kon.; *Sp. ventricosa*, de Kon.; *Sp. glaberrima*, de Kon.; *Sp. cheiropteryx*, de Verneuil; *Sp. Bronniana*, de Kon.; and *Retzia serpentina*, de Kon. Many new and original ideas regarding the stratigraphical distribution of the species by that distinguished Belgian *savant* are also there introduced, to which I would recommend the attention of those who may feel interested in the subject.

In an illustrated catalogue of all the Scottish species of carboniferous Brachiopoda at present known, now preparing for THE GEOLOGIST, I shall have occasion to revert to the two contemporaneous (?) carboniferous faunas discovered in Belgium by Prof. de Koninck, which he has designated as the *Fauna of Visé*, and the *Fauna of Tournay*, and which he believes to have recognized also in Great Britain.

THE SPIRIT OF GOOD BOOKS.

ON LAVAS OF MOUNT ETNA FORMED ON STEEP SLOPES AND ON CRATERS OF ELEVATION.

BY SIR CHARLES LYELL, F.R.S., D.C.L.: London, 1859.

(*A Paper read before the Royal Society*, 10*th June*, 1858.)

FOR some years past it has been a commonly received doctrine among continental geologists that lava-streams could not consolidate on slopes or declivities of more than five degrees. When, then, solid lavas were found in various volcanic mountains at high angles, other sources of origin than the mere outflow from their respective craters had to be sought; and thus arose the theoretical idea of the formation of the cone or crater at a late period of the volcano's existence—after for ages numerous lava-streams had issued from it and had become consolidated one over the other into stony beds on successive flat plains—by the uprise and bursting of a vast dome or bubble; and such was called a "crater of elevation".

So commonly in England have we been accustomed to regard the great mountain-mass of every volcano as successively and continuously built up by the lavas and scoriæ rejected from its orifice, that we observe with astonishment the prevalence to which the "crater of elevation" doctrine, by being favoured by Humboldt and Von Buch, and some other great authorities, has attained.

Sir Charles Lyell early observed the danger of allowing this erroneous doctrine to hold its way, or to spread, and from the first edition to the ninth of his "Principles of Geology," he opposed its tenets; and, especially after his return from Madeira, in 1852, he controverted its essential point by some well-selected instances of stony lavas consolidated at steep angles.

Apparently feeling, however, the necessity of grappling with and thoroughly exploding this patronized falacy, Sir Charles, in 1857, visited Etna, and obtained conclusive examples of the capability of lavas forming stony masses on slopes of not less than from 40 to 47 degrees, an account of which he laid before the Royal Society. In October, 1858, Sir Charles again visited Etna, and obtained further confirmatory proofs, which have been engrafted on his original memoir, and appear in the last part, recently issued, of the Philosophical Transactions.

As the "crater of elevation" theory is built entirely upon the assumption that lavas will not consolidate on steep slopes, it is evident that, by attacking and demolishing the foundation, the superstructure must fall, and thus the chief object of Sir Charles Lyell's two visits to Etna was to collect evidence of the consolidation of lavas which flowed down declivities at high angles into tabular stony masses.

The first example given is the highly-inclined stony lava of Aci Reale.

The town of Aci Reale stands on the top of a cliff in which a platform, elevated at some points more than 650 feet above the sea, ends abruptly. The slope of this platform is usually about three or four degrees, and is prolonged two or three miles inland, while the cliff between the town and the sea consists of irregular precipitous terraces, and exposes on its face the truncated edges of several lava-currents, which were noticed by the Canon Recupero in his "Storia Naturale dell' Etna," to which the traveller Brydone called attention in England in his "Letter on the Two Sicilies."

In the face of this steep escarpment, facing the sea, an indentation, near the Bastione del Tocco, affords a longitudinal section of one of these lava-currents dipping east at from 23 to 27 degrees, and presenting all the usual characters of an upper and under scoriæ with a central stony mass.

This case is supported by another still more remarkable and decisive instance, in a branch of the great stream of 1689 which cascaded into the Cava Grande. The lava there consolidated into a central stony mass on an inclination of 35 degrees.

During the eruption of 1852, the lava cascaded more than once over the steep precipice of the Salto della Giumenta, more than 400 feet high, which intervenes between the hills of Calanna and Zoccolaro, and at this spot measurements of inclined stony lava, at angles varying from 35 to 45 degrees, were taken with the clinometer, and in one case even 50 degrees were ascertained.

The next remarkable instance given by Sir Charles is that of a steeply inclined continuous sheet of lava, 5,000 feet higher than the last mentioned, near the top of the great precipice of the Val del Bove, not far below the Cisterna. Thirty, thirty-five, and even thirty-eight degrees are there attained.

Other similar instances are given, and quite enough is done even in this first part of the paper to prove the essential point, that lavas can be consolidated on slopes of considerable steepness.

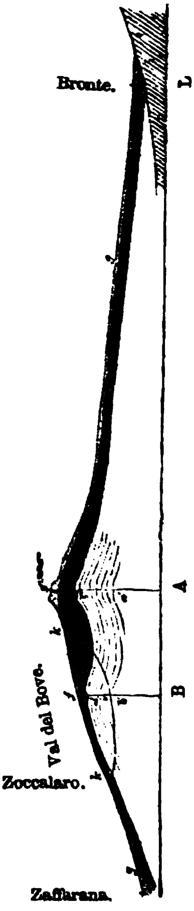
The second part of the paper enters into the subject of the structure and position of the older volcanic rocks of Mount Etna, as seen in the Val del Bove, as also on the proofs of a double axis of elevation; and by these means the "crater of elevation-hypothesis" is again refuted, and the opinions of M. Elie de Beaumont, both as to theory and many important matters of fact, are controverted.

From a point in the Val del Bove called the Piano di Trifoglietto, midway between the Serra Giannicola and the hill of Zoccolaro, the beds of lava radiate in all directions (shown by the arrows in the map of the region of Etna and the Val del Bove at page 321); and from this quaquaversal dip Sir Charles assumes this point (T in the map referred to) to have been an ancient centre of eruption distinct from the present cone of Etna, and that Etna had therefore at one period a double axis, or two points of permanent eruption, with an intermediate valley, or intercolline space, between the two cones, which became gradually filled up by lavas and fragmentary matter. For the sake of distinguishing these, the extinct axis is termed the axis of Trifoglietto, and the present centre of activity the axis of Mongibello,—the modern Sicilian appellation of Mount Etna.

The former existence of an old centre of eruption in the Piano del Trifoglietto had been inferred independently by S. Von Waltershausen from the convergence towards a middle point in that area of thirteen or more dikes of greenstone, one of them of enormous dimensions, visible in the surrounding escarpments. The same geologist also observed in the gigantic buttresses of the cliffs, 2,000 and 3,000 feet high, between the Giannicola and the Rocca del Corvo, that while in the lower part of the precipices the lava-beds dip at high angles inward towards the escarpment, or away from the Val del Bove, those in the middle portion become horizontal, and those nearer the summit dip towards the Val del Bove, as if they were sloping away from some other point near the present great centre of Mongibello.

The change of dip in the inferior, medial, and uppermost beds of the Giannicola, and the convergence of the greenstone-dikes towards the Trifoglietto centre are inexplicable by the "crater of elevation theory," but become plainly intelligible on the principle of a double axis of eruption. Then, in the lower beds we perceive the lava streams flowing away from the old cone of eruption, and mingling in the intercolline space with the currents ejected from the Mongibello crater, until, in the levelling process thus being effected, the horizontality of the succeeding lavas of the middle portion occurs, and after this the streams from the existing cone, flowing down in greater force than those from Trifoglietto, gradually overflowed and extinguished it—the lavas which thus flowed down presenting, of course, the opposite dip to those below, or towards the centre of Trifoglietto.

LIGN. 1.—IDEAL SECTION OF MOUNT ETNA TO ILLUSTRATE THE THEORY OF A DOUBLE AXIS OF ERUPTION.



A, axis of Mongibello; B, axis of Trifoglietto; *a*, *e*, and *b*, *i*, *d*, older lavas, chiefly trachytic; *c*, *c*, and *d*, *f*, lavas chiefly doleritic poured out from A after the axis or focus B was spent, and before the origin of the Val del Bove; *g*, *g*, scoriæ and lavas of later date than the Val del Bove; *h*, *i*, *k*, Val del Bove (the faint lines represent the missing rocks); at *i* the beds dip away from the Val del Bove; in the middle (*e*) they are horizontal, and at the top (*k*) they dip towards the Val del Bove; L, older tertiary and secondary rocks.

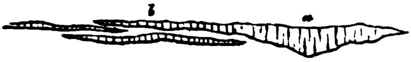
The points of argument next brought forward are the want of continuity in the older and modern parts of Etna, and the truncation of its summit: these are followed by a discussion on the hypothesis of upheaval by injection. Geologists who assume that lava cannot congeal into continuous stony layers on slopes exceeding five or six degrees, must unavoidably embrace the conclusion that nine-tenths of the lava-beds which constitute the nucleus of Etna, and not a few also which overlie that nucleus unconformably, were brought into their present position by mechanical forces, after the materials of the mountain had accumulated on nearly level ground,

M, Elie de Beaumont has suggested that when new fissures are produced during an eruption, radiating from the centre, and traversing the nucleus of the mountain, the lava rising simultaneously to the rim of the highest crater would fill such fissures, causing a tumefaction and distension of the whole mass, and that thus a greater or less upheaval of the cone might result. There is no actual data, however, for deciding that the dyke-making process thus appealed to is usually attended by upheaval. On some occasions, as proved by the observations of Scacchi, Schmidt, and others, it indicates a collapse, or partial subsidence of the flank of the cone. That an uplifting of the incumbent mass must accompany the injection of liquid matter through fissures which are not perpendicular (Sir Charles notices some such fissures inclined at an angle of 75 degrees to the horizon), no one can deny; and therefore, while rejecting the theory of a single terminal catastrophe, or any paroxysmal development of the elevating force, we may fairly ascribe no small influence to those disturbing operations, by which such innumerable dikes have been formed near the principal centres of eruption. But the great points to be kept in view are whether the quaquaversal arrangement of the beds in cones like Etna, and the high inclination of the lavas and scoriæ are not mainly, and in many cases exclusively, due to eruption; and whether the upheaving power, granting its intervention, does not play a very subordinate part. Whether, in fact, it is more probable that, following the proposition of M. de Beaumont, a large portion of the lava-beds now dipping at an angle of 28 degrees had an original slope of only 5 or 6 degrees, the remaining 20 degrees being due to upheaval; or whether the converse may not be more truly assumed, that the 23 degrees may have been the original average inclination, and that the additional 5 or 6 degrees may have been gained by subsequent elevatory movements—in other words, that a fifth part alone of the whole dip may be ascribable to elevation.

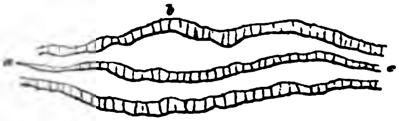
The supposed frequent injection of lava in beds conformable to tufaceous strata, and to which Waltershausen attributes much of the upheaval of the mass of Etna, is then subjected to a similar scrutiny and carefully considered.

"Had the lavas," writes Sir Charles, "which slope away from the ancient centres of Trifoglietto and Mongibello been in great part injected between the tuffs, we should have frequently seen them penetrating through the dikes. But though these last are of so many different ages, and are continually seen to traverse the alternating lavas and tuffs, I could discover no instance of such dikes being in their turn traversed by lavas. It may be asked, how in the escarpments of the Val del Bove can we distinguish a lava which has flowed originally at the surface from a tabular mass of rock which may have been forced, when in a melted state, into a fissure between two layers of tuff? I reply, that the lava has almost invariably its upper and lower scoriæ, and sometimes immediately beneath the latter a layer of burnt tuff, such as I saw in the Balzo di Trifoglietto, at various heights in Monte Zoccalaro, and in the valley of St. Giacomo, where I traced a red tuff for a great distance, underlying the most powerful of the older lavas. Such red layers are never in direct contact with the central and overlying crystalline stony layer, for there intervenes always a fundamental stratum of fragmentary and scoriaceous matter between the stony bed and the burnt tuff below. On the other hand, I looked in vain for an instance of some powerful sheet of lava which had one of these brick-red clays *above* as well as below it. Had the crystalline lavas, whether trachytic or doleritic, whether slightly or steeply inclined, been in great part intrusive, they would have altered the tuffs as much *above* as below them. Moreover, they must have given rise to innumerable faults; for while they vary in thickness from 3 to 60 feet, they are not persistent for indefinite distances, but often thin out rapidly in both directions. They ought therefore, had they been injected, to have lifted up the incumbent deposits partially, so as to give rise to many conspicuous faults. For these reasons, I can not adopt the conclusion that the upheaval of Etna has been largely due to the injection of lavas in sheets parallel or conformable to the tuffs and fragmentary materials."

M. Elie de Beaumont in his celebrated essay on Mount Etna insists on the uniformity in thickness and parallelism of the many hundreds of lava-beds which are presented on the escarpments of the Val del Bove, and on their continuity for great distances, as facts confirmatory of the doctrine of their original horizontality and subsequent upheaval into their present positions, referring their occasional steep inclinations to their liability to be bent together, like the regular sedimentary strata which have undergone flexures in mountain-chains. This assertion has not escaped the keen observation of Sir Charles Lyell, and consequently we have a portion of his paper devoted to the evidence of pseudo-parallelism and the want of uniform thickness of the beds forming the escarpments of the Val del Bove. A conspicuous selected case of want of uniformity in thickness of stony layers in the northern escarpment—one bed attaining forty-feet in its thickest part—and instances of non-parallel strata to the south of Finocchio Inferiore, and at the Serradel Solfizio, with an example of curvatures in the lavas of Zoccolaro effectually



Lign. 2.—Non-parallel Lavas. Want of Uniformity in Thickness of Stony Layers in Northern Escarpment of the Val del Bove.



Lign. 3.—Curvatures of the Lavas of Zoccalaro.

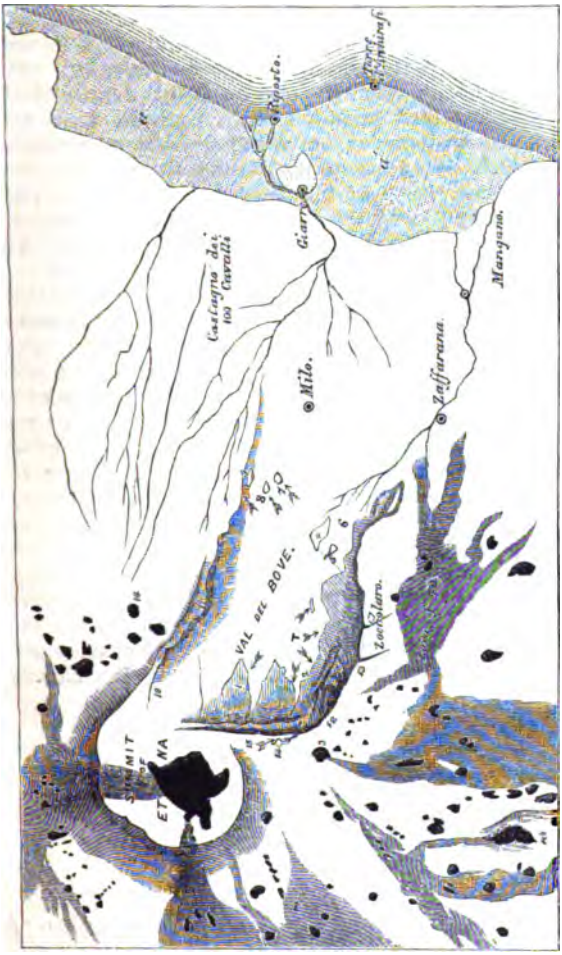
ose of this point, and leave remaining only the easy task of g the analagous form and arrangement of the ancient and n lavas.

third part of Sir Charles's paper is devoted to the relation of canic rocks of Mount Etna to the associated alluvial and ts of Giarre.

This part first enters into the origin of the Val del Bove, and how is due to aqueous erosion.

The origin of that large crateriform valley has been sometimes attributed to a sudden catastrophe connected with those movements which are supposed to have given rise to the mountain itself; but if the doctrine of a double axis be admitted, and the reasoning advanced in this paper be conceded, it is certain we must come "to the conclusion that the mountain, with its lavas and tuffs sloping away from

MAP OF ETNA, THE VAL DEL BOVE, AND THE COAST OF RIPOSTO AND TORRE D' ARCHIRAFI.



1. Giannicola.
2. Rocco del Corvo.
3. Montagnuola.
4. Hill of Calanna.
5. Salto.
6. Valle di Calanna.
7. Finocchio.
8. Musara.
9. R. Capra.
10. Valle del Leone.
11. Serra del Concazze.
12. Schiera dell' Asino.
13. Serra del Solfizio.
14. Cisterna.
15. Piano del Lago.
T Axis of Trifoglietto.
a, *a*, Alluvial deposits.

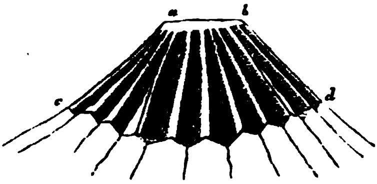
The darker shaded portions represent certain lava-currents, and the black spots indicate the sites of cones of eruption.

more than one centre, and pierced by a succession of dikes, was already complete before the Val del Bove began to be formed."

The alluvial formation on which Giarre and some other towns on the coast are built, attests the removal, at some unknown period, of a vast quantity of stony fragments from that part of Etna which lies immediately in the direction of the Val del Bove; and if it could be shown that this transported matter came down from that great valley, it would go far to prove that the abstraction of the missing rocks was for the most part effected by aqueous agency. On examination it actually appears that the portion of this deposit,—which consists of coarsely stratified materials, with rounded and angular blocks some nine feet in diameter, but without striations or scratches like the "glacial drift"—opposite to the Val del Bove is conspicuous beyond the rest for its volume, and by being exclusively composed of the wreck of the volcano itself, the blocks being of trachyte, basalt, dolerite, grey-stone, and indeed of every variety of rock met with in the Val del Bove; some being evidently derived from dikes.

As usual, Sir Charles provides against attack by combatting the probable objections likely to be made to his notions. "It may," he says, "perhaps be suggested that the deposit at Giarre and Mangano might have been swept down by rivers from the old cone when it was still entire, and before the caldera originated, in favour of which theory it might be urged that in the Val del Bove at present we discover no action of running water capable of causing extensive denudation; also that we may well imagine, during some former suspension of eruption on the eastern flank of the volcano, that ravines like the Cava Grande may have been gradually excavated in the wide space separating the two hills of Calanna and of Caliato."

In order to test the value of the hypothesis, Sir Charles explored from their lower to their upper terminations the two principal valleys of aqueous erosion, which slope upwards from the foot of the cone to the southern margin of the Caldera. Those who are conversant with Junghuhn's "Volcanos of Java" are well aware of the nature and value of this test; for they will remember that the flanks of volcanic cones which are in full activity are free from furrows eaten out by running water; whereas, such as have been long extinct, or are in a state of moderate activity, exhibit a great number of ravines from 300 to 600 feet deep, excavated by torrents, and parted from each



Lign. 3.—Furrows of Aqueous Erosion on the Cone of Tengger. From Junghung's "Java."

other by ribs or ridges of volcanic rocks, compared by Junghuhn to the spokes of an umbrella. All these furrows grow narrower and shallower when traced upwards, and come to an end before they reach the rim of the crater; whereas, in such volcanic cones as have been truncated by explosions and subsidences, after considerable aqueous erosion, the rim is invariably indented. On applying this rule it was found that the crest of the southern escarpment of the Val del Bove, between Montagnuola and Zoccolaro, was very entire and unbroken; "but that there were notches, or deep depressions, several hundred feet deep, precisely at the two points where the upper ends of the valleys, called the Val dei Zappini and the Valle del Tripodo, joined the crest. Hence, it is natural to conclude that the valleys in question are of older date than the Val del Bove, and that their higher extremities were once prolonged towards the upper region of the cone, and were cut off when the Caldera was formed. Such an explanation of the facts would, however, be fatal to any theory which refers to a single catastrophe, or to any one mode of operation, whether slow or sudden, the upheaval of Etna, the tilting of the inclined beds, and the opening of the great cavity called the Val del Bove."

The erosion of the Valle del Tripodo is stated to be still going on, and a small inclined delta at its mouth furnishes the means of learning how much matter has been brought down in a given time, or during the sixty-six years which have elapsed since 1722, when a powerful flow of lava crossed the lower extremity of a narrow valley, and suddenly put a stop to the transportation of alluvium to lower levels. "The waters of the torrent, even when most swollen, no sooner arrive at the margin of the lava, than they are absorbed by its spongy, scoriaceous crust, and by the superficial rents and grottos in which it abounds. The engulfed waters continue their course underground; but the mud, sand, and boulders are all left behind and form a deposit, already several hundred feet long and thirty or forty deep, which "proves, on the one hand, how much erosion has gone on in little more than half a century; and, on the other, how entirely all aqueous erosion ceases in areas once covered with fresh lava, and where a superficial drainage is turned into a subterranean one."

It is not, however, attempted to attribute the origin of the Val del Bove exclusively to the action of running water; and it is presumed local catastrophes of paroxysmal intensity may have given rise to the first breaches which ended in the production of this enormous cavity.

The Cisterna, an elliptical hollow, now about 120 feet deep, was produced in 1792 on the platform of the Piano del Lago by the sinking of the ground, and deepened again by subsidence in 1832. On a still higher level near the Philosopher's Tower, is a fosse-like depression known to have originated during the same eruption of 1832. The great rent of Mascalucia, a mile in length and 30 feet deep, formed in 1381, is still open; and another fissure, 6 feet broad and of unknown depth, was formed in the plain of San Lio in 1669, and is said to have been twelve miles long, reaching to near the summit of Etna.

"Such openings on the steep parts of a cone might easily become water-courses, and give passage to floods during the winter's rain and the melting of the snow, and these might gradually deepen and widen such fissures." Paroxysmal explosions like that of Vesuvius in the year 79 might also be powerful agents; and, "if a great explosion happened to be lateral instead of central, the new chasm being commanded by higher ground, or by the region of snow, floods of water would at certain seasons sweep down into it, and might increase its dimensions. "To account for the position of so great a cavity on one side only of a cone, we may, in the case of Etna, imagine a connection between the Val del Bove and the old axis of Trifoglietto. The ancient habitual duct or chimney may, like that of the ancient Vesuvius, after being plugged up for ages, have again given passage to vast volumes of pent-up gases or steam, blowing up the incumbent lavas of Mongibello, which had filled the crater and overtopped the secondary cone. Moreover, the accumulated snow and ice, and consequently the action of running water, may at some earlier period have been greater in the higher region, when the cone of Mongibello was larger and loftier, before its truncation, especially if the first excavation of the Val del Bove dates as far back as the close of the glacial period, or when the Alpine glaciers reached the plains of the Po; for at that time the climate of a Sicilian winter could hardly fail to be colder than now."

Isolated outliers of ancient rock, such as Finochio and Musara, are striking monuments of waste, helping to prove the former continuity of the northern escarpment of the Val del Bove in a southerly direction; and the multitude of dikes projecting from ten to fifty feet above the general level of the ground in every part of the escarpments, shows clearly to what an extent the softer and more destructible beds have been wasted away by atmospheric aud torrential action. Such dikes are records of the former existence of masses of rocks now no more, though we can still trace the exact shape of the fissures by which they were at one period traversed. The lateral ravines also before mentioned bear testimony to the removing power of running water since the Val del Bove was bounded by lofty precipices."

The obliteration of the river Amenano by the lava of 1669 is given as an example of the antagonism of aqueous erosion and volcanic activity; and in like manner it is suggested that "at some former period there may have existed many rivers in the Val del Bove like those now draining the calderas of Palma and Tiraxana in the Canaries; and, like them, they may, after uniting, have issued by one principal gorge; yet they would inevitably be all effaced from the map, and the gorge filled up with stony matter whenever the time arrived, during a new phase of eruption, for fresh floods of lava to traverse the Caldera." Sir Charles then brings forward the great flood of 1755, the only authenticated instance of a great body of water having passed from the higher region of Etna through the Val del Bove to the sea. "An eruption had taken place at the summit of the volcano in the month of March, a season when the top was covered with snow. The Canon Recupero, a good observer and man of great sagacity, was commissioned by Charles of Bourbon, King of Naples, to report on the nature and cause of the catastrophe. He accordingly visited the Val del Bove in the month of June, three months after the event, and found that the channel of the recent flood, now less than two Sicilian miles broad, was still strewed over with sand and fragments of rock to the depth of forty palms*. The volume of water in a length of one mile he estimated at sixteen millions of cubic feet, and he says that it ran at the rate of a mile in a minute and a half for the first twelve miles. At the upper end of Val del Bove, all the pre-existing inequalities of the ground for a space of two miles in length and one in breadth were perfectly levelled up and made quite even, and the marks of the passage of the flood were traceable from thence up the great precipice, or Balzo di Trifoglietto, to the Piano del Lago, or highest platform.

Recupero, in his report, maintains that if all the snow on Etna, which he affirms is never more than four feet deep (some chasms we presume excepted), were melted in one instant, which no current of lava could accomplish, it would not have supplied such a volume of water. He came therefore to the startling conclusion that the water was vomited forth by the crater itself, and was driven out from some reservoir in the interior of Etna.

As it seems unlikely the Canon could have been mistaken as to the region of the mountain whence the waters came, Sir Charles submits as an explanation, that there might have been at the time of that eruption not only the winter's snow of that year, but many older layers of ice, alternating with volcanic sand and lava, at the foot or on the flanks of the cone which were suddenly melted by the permeation through them of hot vapours, and the injection into them of melted matter.

In the first edition of the "Principles of Geology" the existence of a glacier under the volcanic sand and lava near the Casa Inglese is noticed; and if glaciers may thus endure for long series of years, the store of water which Recupero speculated upon as contained in the interior of the mountain seems sufficiently accounted for.

The gradual rise of the sea-coast, and of the inland cliffs at the eastern base of Etna is attested by the existence of alluvial deposits in some places some hundred feet above the sea; while the fossils contained in them, and those contained in the fossiliferous strata cut into terraces at various heights, afford intelligible data for working out the general history of such upheaval. The proximity of land, for instance, is shown by the tusks and teeth of elephants at Palermo and Terra Forte; while the existence at other places, as near the church St. Andrea, below Taormina, of raised beaches containing shells of recent species shows a former coastal line. It seems probable also, from the leaf-bearing tuffs of Fasano, near Catania, that a portion of Etna is of sub-aërial origin, coeval with the upraised alluvial and estuarine formations, and evidence is not wanting to support the inference that a large portion of the mountain is even of posterior date.

---

* A palm is a fraction more than 10 inches English.

The marine tertiary strata of Cefali and Nizzeti are considered by Sir C. Lyell as slightly younger than the Norwich Crag, and "if so, the great mass of Etna, or all that is of sub-aërial origin, being newer than the Nizzetti clays, must be, geologically speaking, of extremely modern date. Its foundations were probably laid in the sea, and were in all likelihood contemporaneous with the basalts and other igneous products of the Cyclopean Isles and Aci Castello, which belong to the period of the fossil shells of Nezzeti and Cefali. When that fauna flourished, the area where Etna now rises was probably a bay of the sea, afterwards converted into land by the outpouring of lava and scoriæ, as well as by the slow and simultaneous upheaval of the whole territory. During that gradual rise the ancient river-plain of the Simeto, in which were embedded the remains of elephants and other quadrupeds, together with certain marine strata (those of Camuliu) formed near the mouth of that river, acquired their present comparatively elevated position. The local eruptions of La Motta and Paterno took place about the same time—*i. e.*, during, or immediately after the deposition of the older alluvium, when also the leaf-bearing tuffs of Fasano were formed. In the course of the same long period of elevation the cone of Trifoglietto, and probably the lower part of the cone of Mongibello, were built up. Still later, the cone last mentioned, becoming the sole centre of activity, overwhelmed the eastern cone and finally underwent in itself various transformations, including the truncation of its summit and the formation of the Val del Bove on its eastern flank. At length the phase of lateral eruptions, which is still in full vigour, closed this long succession of events—changes which may have required thousands of centuries for their devellopment, although in the same lapse of time the molluscous fauna of the Mediterranean has scarcely undergone a twentieth part of one entire revolution."

After a recapitulation of the principal arguments of the third part, the author concludes his admirably lucid and logical paper with the expressal of his conviction, that "upheaval has no where played such a dominant part in the cone- and crater-making process as to warrant the use of the term 'elevation-craters' instead of cones and craters of eruption—a conviction in which we think most reflecting geologists will concur, and which seems, through the medium of Sir Charles's paper, to have attained influence in the head-quarters of the supporters of the "elevation-theory" from the fact, that the Geological Society of Berlin, at which city that hypothesis was first propounded, has, by permission requested of its author, translated it into German.

No doubt the weight of such names as those of the late venerable Baron Humboldt and M. Elie de Beaumont caused the "elevation doctrine" to be received generally more from the credibility of such authorities, than from the merits of the doctrine itself. In the recent death of the first illustrious philosopher it has lost one of its most powerful supporters, and rumour even speaks of the second as a seceder, in having inclined to the opinion that the "crater of elevation theory" is now no longer tenable.

Since the reading of the above paper, Mr. Scrope has supported its arguments by a voluminous paper before the Geological Society. Sir Charles Lyell himself has also delivered a lecture on the subject at the Royal Institution, and has, in the last number of the Philosophical Magazine, published some remarks on Professor C. Piazzi Smyth's supposed proofs of the submarine origin of Teneriffe and other volcanic cones in the Canaries. This last brochure was drawn forth by a chapter on geology and volcanic theories, appended to a "Report on the Teneriffe astronomical experiment of 1856" by the Scottish astronomer, in which it was stated that fossil shells had been found upon the slopes of the crater there. As this statement involved points of high theoretical interest, and was made to stand in the report as expressly confirming the "elevation" of the great crater of Teneriffe, Sir Charles wrote to the Professor to know under what geological circumstances he, or his informants, had detected such shells. It appears, however, that this statement of the fossil shells was made entirely upon mere report, and that it is without any foundation. As this was published under the sanction of the Admiralty, Sir Charles has felt himself called upon to refute it, and has added correct details of observations made by himself and Mr. Hartung at Teneriffe and in the islands of Grand Canary and Palma, which, so far from corroborating the "crater of elevation-hypothesis," in this instance are directly opposed to it.

Future observation will now probably add additional testimony to the more reasonable view of the general formation of volcanic cones and craters by eruptions; and since attention is so thoroughly drawn to the subject there will doubtless be many other writers upon it: but, however numerous or excellent they may be, to Sir Charles Lyell will ever be due the double merit of first detecting the dangerous spread of a false doctrine, and of having had the boldness of making the first attack upon it in the face of the support it had received from some of the most eminent of the continental geologists.

FOREIGN CORRESPONDENCE.

COMMUNICATED BY COUNT MARSCHALL.

From the Proceedings of the Imperial Academy of Sciences, Vienna, October, 1858.

1.—*Parasitic Algæ in Shells.*

Certain channels met with in the shells of several Acephalous and Gasteropod mollusca have generally been considered to be nutritive channels, and to stand in organic connection with the pores of these shells. Professor Wedl after close examination of a number of recent and fossil specimens, has proved them to be accidental deteriorations of the shells, owing their origin to parasitic algæ of most delicate structure. In the recent specimens these channels stand in communication with exiguous cavities, including pedunculated cellules, filling up the channels themselves, and emitting a great number of lateral ramifications. The presence of Amylum in the nucleus, and in the cellules connected with it, manifests itself by the vivid brown tints they assume when brought in contact with diluted tincture of Iodine. The algæ themselves have of course ceased to exist in fossil specimens, but the characters of the channels in them, their irregular distribution, their connection with minute cavities, &c., are such that the identity of origin with those observed in living individuals can hardly be doubted. As far as investigations have hitherto proceeded, it may be inferred that *fresh-water* shells suffer more from these vegetable parasites than those of marine species.

2.—*Native Platina.*

Prince B. Demidoff has lately presented to the Imperial Mineralogical Museum a pepite of native Platina, weighing 11¼ lbs., found in his mines of Nishney Tagilsk, together with other large masses of the same metal, of which the most considerable have been very liberally offered by the noble owner to the museums of Berlin and St. Petersburg. The Vienna pepite measures 5 inches in length, 4 inches in breadth, and 3 inches in height. Its surface is covered with impressions similar to those on several pepites of native gold, indicating its origin within a fissure, and bearing some analogy (as the late P. Partch had remarked long ago) with the superficial impressions peculiar to meteoric iron. The impressions are partly filled with chromate of iron, which is generally associated with native Platina.

NOTES AND QUERIES.

Summer-Meetings of the Geologists' Association.—As a member of the Geologists' Association, I must ask permission to trespass on your space for the means of suggesting that it would be desirable for that Society to institute field-meetings during the present summer-season. I know there are other members who like myself regret that our labours appear to have terminated with the winter-session of paper-reading and lectures. Now, Sir, I know it was felt at the outset of the Association by very many of the working geologists who so freely came forward to join it, both those resident in London and those in the country, that such field-meetings were as, or even more, essential to the instruction of young and working geologists, and to the general progress of the science—for I am one at least who thinks the humblest labourer of some value in the community—as the instructive readings and discussions at the Society's chambers. It is not altogether in-door instruction we really want; there is far more to be learnt in the field; and doubtless there, too, we should find gentlemen with the right, both legal and intellectual, to add the F.G.S. to their names, ready to aid and assist us, as we have done already at the Society's rooms.

Some one, I think, before the institution of the Society, did propose such field-meetings, and I would ask, could not one, at least, be held with advantage annually in some locality or place of geological interest, when suitable papers might be read, and followed by discussions; fossils and other objects brought together; excursions made, and other means adopted for collecting and imparting information?

Perhaps something might be established in imitation of the plan of the British Association for the Advancement of Science, though, of course, less pretending. One or two hundred working members might be got together, and by a steady onward course for a few years, a large amount of valuable material might be got up. It is true we have the Geological Societies of London and of Edinburgh, two most important and influential bodies; but these Societies, from the restrictive character of their respective constitutions, and the nature of the rules by which they are governed, are totally useless to the class of persons which the Geologists' Association was designed to benefit, and I believe this class to be far more numerous than it is generally thought.

I cannot help thinking the time has arrived when we should set about doing something of this kind, and I shall look for the next month's Geologist with no small anxiety, in the hope to find that some such course of action shall have been determined upon, and that the Society you so freely helped to established may, without attempting to emulate the more learned bodies, properly develope another, and not the least important of its sources and means of instruction.

I have, moreover, preferred that my idea should, by your kind consent, be propagated in your pages, as many members of the Association are included in the multitude of your readers, and hence suggestions will most likely be made which may add to the value of mine. The excursion-trains, at this period running on every line in the kingdom, afford the means of country-members meeting at any appointed place their city brethren, and interviews and introductions would thus take place to which higher fares and less agreeable travelling would be a barrier in the winter months.—I am, dear sir, your well wisher and reader, A Provincial Geologist.

Cheap Cabinets for Fossils.—Sir,—What is the cheapest way of getting cabinets made for fossils and minerals? It seems almost impossible in the country to buy any suitable articles of this kind second-hand. Even a moderate-size new cabinet seems usually to cost not less than ten or twelve pounds. Could common chests of drawers be made available by any alteration which would not be expensive?—I am, sir, yours, &c., A CONSTANT READER.

The cheapest kind of cabinet which can be made, and which is also one of the most useful, is formed by a set, of greater or less number, of plain deal trays with marginal rims. These trays can be rested on cross-bars in a simple deal case, a cupboard, or recess.

Such trays can be made in town for about three shillings each.

Mr. Charlton, the resident housekeeper of the Geological Society, can be recommended for the manufacture of very excellent cabinets of a superior character.

CASE OF A TOAD.—At one of the meetings of the Wernerian Natural History Society, a notice was given of the incarceration of a *live* toad in the wall of Fort-William Barracks, Calcutta, for the long period of fifty-four years.

RESPIRATION OF FROGS.—It appears, from a series of curious experiments performed by M. Edwards, and detailed in the "Annales de Chimie et Physique" for January, 1819, that frogs, toads, and lizards are preserved alive and in health under water for weeks, by means of the air contained in the water, which they abstract, not by the lungs, but by the skin.

COUNT D'ARCHIAC'S NOTICE OF "SILURIA."—Count d'Archiac was charged by the President of the Geological Society of France with a report of the principal changes which Sir Roderick Murchison had made in the last edition of "Siluria,"* and his notice of that work recently published in the Bulletin of the French Geological Society, is not only the best *resumé* of the objects and intentions of Sir Roderick's masterly labours we have yet seen, but offers also several observations and suggestions well worthy of note. The report follows in historical order the various advances made from the substitution (in 1835) of the Silurian System, with its ground-work of arrangement, for the vague ill-digested accumulation of rocks known under the ancient general denomination of grauwacke, to this last most comprehensive description of the Lower Paleozoic rocks, both in their details and in their entirety. Interesting as it is to know how far and how thoroughly the labours of any of our countrymen are appreciated by foreign *savans*, our object is now more to draw attention to a slight addition which M. d'Archiac has made to this work in his review.

In speaking of the admirable list of fossils prepared for "Siluria" by Messrs. Salter and Morris, Count d'Archiac repeats the remarks he has already made upon similar lists executed in England, namely the absence of a numerical table expressive of, 1st, the total number of genera and species of each class; 2nd, the total number of species in each geological division; 3rd, the species common to two or more of the geological divisions, in such wise as to be able to deduce the degree of importance of their zoological relations, and consequently the analogy or difference of the circumstances under which the strata were deposited. This want M. d'Archiac fills up by a table prepared from the list above referred to, which, for the benefit of English geologists, we transfer to our pages.

How highly the great French geologist values those untiring and unceasing efforts that have produced that Silurian system which, founded on a limited portion of the British Isles, has been now, by the investigations and researches of foreign, and of our colonial geologists, applied in its integrity to the whole world, is given best and briefly in his own words:—"SILURIA, dont nous espérons que l'auteur donnera encore plus d' une édition, restera toujours comme le magnifique couronnement d'un vaste ensemble de travaux dont les annales de la science nous offrent peu d'examples."

---

* For a notice of this admirable book see THE GEOLOGIST, Vol. II, p. 88.

NUMERICAL TABLE OF THE FAUNA AND FLORA OF THE BRITISH SILURIAN STRATA.—BY COUNT D'ARCHIAC.

Classes, Orders, and Families.	Number of genera.	Number of species.	Silurian Strata.							Species common to Two Divisions.										To Three.					To Four.			To Five.
			1	2	3	4	5	6	7																			
			Lingula beds.	Llandeilo beds.	Caradoc and Bala beds.	Llandovery beds.	Wenlock beds.	Ludlow beds.	Beds of passage.	Species common to divisions 1 and 2.	2 and 3.	2 and 6.	3 and 4.	3 and 5.	3 and 6.	4 and 5.	4 and 6.	5 and 6.	6 and 7.	Species common to divisions 2, 3, and 4.	3, 4, and 5.	3, 4, and 6.	3, 5, and 6.	4, 5, and 6.	Species common to divisions 2, 3, 4, and 5.	3, 4, 5, and 6.	4, 5, 6, and 7.	Species common to divisions 2, 3, 4, 5, and 6.
Flora	8	13	1	5	...	1	...	6	1	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...
Fauna:—																												
Amorphozoa	5	6	...	...	3	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...
Polyparia	33	84	...	4	23	26	66	10	...	...	...	...	5	2	1	7	...	3	...	...	5	...	...	2	1	2	...	1
Echinodermata	43	76	...	...	20	6	34	17	...	...	...	...	...	...	...	1	...	...	...	...	...	...	...	...	...	...	...	...
Annelida	15	28	2	8	8	3	6	8	...	...	...	...	1	...	...	...	...	2	...	...	1	...	...	1	...	...	...	...
Crustacea	44	186	11	34	82	17	36	39	11	1	3	...	3	3	...	2	...	6	5	1	2	...	...	3	...	2	1	...
Bryozoa	22	65	1	22	25	5	25	1	...	...	3	...	1	4	...	1	...	...	...	...	1	...	...	...	...	1	...	...
Mollusca. Brachiopoda	19	178	3	18	67	68	79	30	1	...	3	...	7	2	...	12	...	9	1	1	8	...	...	10	3	1	...	1
Monomyaria	3	30	...	...	8	5	12	17	...	...	...	...	...	...	...	...	...	2	...	...	...	...	2	3	...	...	...	...
Dimyaria	15	85	...	2	31	13	15	41	...	...	...	1	1	1	1	...	2	5	...	...	2	...	1	...	...	...	...	...
Gasteropoda	19	84	...	3	25	25	18	27	1	...	...	...	3	1	1	1	2	5	1	...	...	...	...	1	...	...	...	...
Heteropoda	1	14	...	2	7	6	3	4	...	...	...	...	1	...	...	1	...	...	...	1	1	1	...	...	...	...	...	...
Pteropoda	5	18	...	6	7	3	3	4	...	...	...	...	1	...	...	...	...	1	...	...	...	...	...	...	...	1	...	...
Cephalopoda	8	69	...	4	26	13	22	30	...	...	...	...	1	...	...	...	...	5	...	...	1	...	3	1	...	3	...	..
Fish	6	12	...	...	...	...	...	8	7	...	...	...	...	...	...	...	...	...	3	...	...	...	...	...	...	...	...	...
Total	238	934	17	103	332	193	322	236	20	1	9	1	24	13	3	25	4	38	10	3	22	1	6	21	4	10	1	2

REVIEWS.

Illustrated Index of British Shells, containing figures of all the recent species, with names and other information. By G. B. Sowerby, F.L.S. London: Simpkin, Marshall and Co., 1859.

The magnificent work on British shells by Mr. Hanley and the late Professor Forbes, must remain, for a long time at least, the standard book on British mollusca. Its price, amounting to some pounds, however, is a barrier to its being more extensively accessible, while there are thousands of inquiring minds who desire some reliable source from which, by comparison of the shells they find with some good figure, they can at least recognize a species, and thus find some firm foundation on which to continue their investigations. Such a source is Mr. Sowerby's book, although it is little more than an illustrated catalogue of our native shells. The figures are very good, and appear to be original representations of properly selected specimens; no slight consideration, for our attention has been often drawn to the evil effects of the practice of copying from other plates, in presenting false ideas, by departures from the original and proper outlines of the object thus occasioned, the errors of the draughtsman, often rendering the determination of species difficult and obscure, and otherwise impeding the progress of science. We rejoice that Mr. Sowerby's book has passed well through our scrutiny on this point, and that we can consistently wish it the extensive sale it merits.

Advanced Text Book of Geology, Descriptive and Industrial. By David Page, F.G.S. Second edition, revised and enlarged. London and Edinburgh: William Blackwood and Son. 1859.

This treatise, the first edition of which, so well known, is reported to have sold to the extent of twenty thousand copies, was designed as a sequel to the author's "Introductory Text Book," although it has been prepared in such a manner as to stand also as a separate and independent work. The latter or introductory work gives an outline of the science intelligible to beginners, and sufficient for a general acquaintance with its leading facts; that under notice, or the "Advanced Text Book," presents the subject more in detail, and is "intended for senior pupils and those who desire to prosecute the study in its principles as well as deductions."

The author's views are good of a right system of teaching; and no geological book for scholastic purposes in the English language surpasses Mr. Page's in this respect; nor is the carefulness displayed in the correctness of the general material of the work to be passed over without laudatory comment.

This second edition has been enlarged, "firstly, to embrace whatever is new and important in the science; secondly, to afford space for additional illustration; and thirdly, to combine, as far as possible, the principles with the deductions of the geology."

This additional matter is ordinarily given "in subordinate type and in such a form as not to interfere with the continuity of the original textual arrangement." So far so good; and the matter thus introduced is certainly not without much value, but we caution against increasing the dimensions of a Text Book. It is, in our opinion, dangerous both to its practical and to its pecuniary success; while it is desirable for its attractiveness to the student—no mean consideration—to restrain it within the most moderate limits.

We are glad to find Mr. Page himself entertains an opinion of this kind, for he says that it has been his aim "to improve rather than to enlarge—to keep the volume abreast with the latest discoveries and advancing views of our leading geologists, and yet to prevent it from exceeding the limits of a compendious Text Book." We hope Mr. Page will rigidly adhere to these views, for we should be sorry indeed to see so good and useful a book run to seed.

Amongst the new matter introduced of importance are the remarks upon the characters and structure of the Himantopterus, the Pterygotus, and Eurypterus, illustrated by some very fairly executed woodcuts, and a fuller notice of the oolitic mammals than appeared in the first edition.

A woodcut of the seal discovered by Mr. Page in the Pleistocene clays of the Clyde is another new addition. Mr. Page has also given us the improved classification of the members of the Old Red Sandstone, in accordance with the late observations which Sir Roderick Murchison has brought together with so much labour and acumen, and has grooped with his usual skillfulness of generalization. We have also the results of Dr. Bigsby's laborious revision of the classification of the North American Paleozoic rocks; and two more definite and comprehensive lists of plants and animals, instead of the mere outline-notes of the former edition.

It would, however, be supererogatory of us to extend our notice or criticisms of a book which, from its usefulness and its moderate price, is sure of extensive circulation, and will probably also very generally replace and supplant the former edition in the hands of its former readers; and for this very reason will have its merits and demerits (however few these last may be) so fully criticised and exposed by others, that neither will escape observation and comment. Hence we may fairly be content to close our notice with the advice to the teacher, the scholar, and the student, that they can not spend their money, nor their time upon a better book.

A Week's Walk in Gower, from the pen of Dr. Bevan, who is known to our readers from his contributions to this journal, is written in a fanciful style, and tells us what the author saw, and what we should see if we spent the same amount of time in the peregrination of that small peninsula of South Wales.

The reviewer's task may generally be similized to that of Tom Moore's "child at a feast," who but "sips of a sweet, then flies off to the rest." And true to the simile we have selected, and in this case leaving all those other attractions of "iron-bound coasts with glorious sea-views, picturesque little valleys and inland dells, old churches, still older castles and camps, and druidical remains," so pleasing and attractive to other tastes, we fly at once to the geological nectar of the mellifluous sweets of Gower, and take our readers to the famous Bacon and Mitchin Holes—two caves which have made Gower famous.

Dr. Bevan tells us to get a guide to them if we can, and, next to that, considers the most important thing "to get good bearings; for what with devious lanes and sand-drifts, it is by no means an easy place to find, for the caves themselves, though large, all face the sea, and are so overhung by the cliffs that it is altogether impossible to see them from the land. I have found one of the best landmarks to the Bacon Hole to be Pennard Church tower, which is almost in a straight line with it. The Bacon Hole, more particularly, is an extremely interesting place, as bones are still to be procured; but a pickaxe is required, the ordinary geological hammer being of little avail against the hard breccia in which they are enveloped. The interior has been systematically quarried and blasted to obtain the bones, most of which are to be seen in the Swansea Museum; but the details of the operation, and of the successive layers that were exposed, are so very instructive, that I cannot help borrowing an account from Mr. Starling Benson's excellent paper in the Transactions of the Institution. The floor of the cave will be seen to fall from the entrance towards the inner part, while the interior of the roof is pointed (the two sides meeting at an angle), and is covered by a layer of stalactite, and the floor is also overlaid with stalagmite, which was blasted through, and a cross trench opened down to the solid limestone. First, then, they arrived at a bed of alluvial earth, in which were recent shells (still to be found there) and bones of ox, red-deer, roe-buck, and fox, succeeded by a thickish layer of stalagmite. Then came a bed of hard breccia, with bear-, ox-, and deer-bones; then more stalagmite, below which was more breccia, and a deposit of cave-earth,—the grand treasure-house of osseous remains. Then came bones of the gigantic mammoth, rhinoceros, hyæna, wolf, bear, ox, and deer. The lower layer of the black sand seemed to be almost exclusively occupied by mammoth-bones, the only others being a tooth of badger, and one of a kind of pole-cat. The mammoth-remains are most wonderful, and almost worth a special journey to Swansea to see them. The tusk was two feet round, and five feet five inches long; besides which, there were humeri, femora, tibia, ulna, radius, and several phalanges. Below this important bed was more stalagmite, with shelly sand, containing *Clausilia nigricans*, *Littorina littoralis*; also bones of birds and of arvicola. Here was a grand storehouse of fossil remains, and a large field for speculation as to the conditions under which all these inhabitants lived. How the shells got there at the bottom of all these layers, and at a height of thirty feet above the sea, is easily explained. When they lived, the coast had not been elevated; consequently, the mouth of the cave was probably under water at high tide, allowing the shells to be deposited, and birds and water-rats to enter at low tide.

With regard to the *Clausilia*, however, which is a land shell, it was probably not deposited until the floor of the caves began to be dry, and above water. This elevation, which is to be found in all the caves of Gower, is quite borne out by the water-worn appearance of the rocks in Caswell Bay. When the floor of the cave was dry, the mammoth took possession, and lived in it. It is not very likely that his bones were drifted in by the sea, for two reasons: 1*st*, that they were in a state of good preservation, which would not have been the case if they had been well beaten about by the waves; and, 2*ndly*, they all appeared to belong to the same individual, as if he had lived and died there. Then came animals of smaller kinds in greater profusion, succeeded at the top by red deer, &c., animals which have not been for such a great length of time extinct. There are no traces of man below the upper stalagmite; but in the black mud above are pieces of English pottery—a fact of which I was unaware in one of my visits, but which I sincerely regretted afterwards; for, seeing a rapacious cormorant fishing just below me, I flung at it a piece of pottery, which I took to be of more modern extraction; on examining the bones at the Museum, I recognized the antiquarian remains that I had so ignorantly cast away. There is another cave in Gower, which we shall presently visit, in which human traces have been found*—to the best of my knowledge the only two in Great Britain in which such has occurred. A little to the west is the Mitchin Hole, a larger hole than the other, but possessing no remains; so we will wander along the cliffs until we come to Pennard Castle. Pennard Castle is rather a mystery as to where it came from, and where all the rest of the place is gone to. It was very likely built at the same time as most of the other castles; but tradition has been unusally busy, and has asserted that it was built in one night, and destroyed in the same space of time by sand blown over from Ireland."

---

* Traces and relics of man are reported in other instances in Britain.—Ed. Geol.

Another of the Gower lions is a bone-cave, situated under the cliffs in the neighbourhood of Paviland. Dr. Bevan's book does not, however, give the utmost encouragement to the visitor for trying to get there; for he tells us he made a fruitless effort himself with that object; that he only "got half way, and was well pleased to return and take for granted that Dr. Buckland's description, in his *Reliquiæ Diluvianæ*, was correct. It is possible, however, to get a boat at Port Eynon, but it is a long way round, and after seeing the Bacon Hole, scarcely worth the journey; but if the traveller can happen to hit the fortunate conjunction of low-water and spring-tide, he may then get down to the caves without being sea-sick or breaking his neck. It was made public about 1822, although known to the peasants some time before; but in the following year Dr. Buckland visited it, and published the account in the work before mentioned. These caves (for there are two) are the most important in Gower, and the antiquary will share the interest with the geologist, since human relics were found in the shape of bones, articles of ornament, coins, &c. On the cliff above are the remains of a British camp, which, doubtless, was contemporaneous with the skeleton found below; the largest of the caves is the Goat's Hole, in which the floor ascends, and is covered with diluvial loam, mixed with fragments of limestone and spar, recent marine shells, and bones of elephant, rhinoceros, bear, fox, hyæna, wolf, horse, deer, ox, rats, birds, and fragments of charcoal. The recent shells and bones of birds were most plentiful in the interior extremity, and the material in which they were found was earth, cemented by stalagmite. The skeleton was that of a female, the bones stained of a dark red colour, and covered with a coating of raddle, tinged by red oxide of iron. Fragments of ivory too were there, cut into curious and fantastic shapes (probably charms). The coins were of the reign of Constantius. In the second cave—which, from its position as regards the Goat's Hole, Dr. Buckland conjectures was connected with it, and, in fact, with the other, formed part of a large cave, cut away by denudation—were more bones of animals, covered with a bed of fine pebbles. The inquiring palæontologist will find a unique collection of these bones, as well as those from the Goat's Hole, in the Swansea Museum, where they are well arranged and preserved."

The Worms Head is a noted place also in Gower. It is the most westerly point of Gower and Glamorganshire—the end, in fact, of that county in general and of our locality in particular; and with it we conclude our review, as affording a remarkable instance of the abrading power of the sea-waves. It was a noted point in old Leland's day, and he tells us, in his quaint but accurate book: "Ther is in Gowerland by-twixt Swansey and Lochor a litle promontori caullid Worms Head, from the wich to Caldey is communly caullid Sinus Tinbechicus." Dr. Bevan says that "it has obtained its name from the curious arrangement of the rocks which compose it—two or three successive elevations, with causeways between, which, seen from the channel, certainly do look like a large sea-serpent with uplifted head. The force and action of the waves is mightily shown by the queer and fantastic shapes of the rocks, the footpath in one part being carried across the boiling sea by a narrow arch, perilous enough when a strong south-wester is blowing. Immediately in front is the Head, a sheer precipice of more than 200 feet; and yet, high as it is, I have seen the waves dash over the very top, and that too when there was scarcely a ripple visible on the surface of the sea. It is rarely that this phenomenon is visible, but the effect is wonderful—a dense volume of water running up the side of the rock, and breaking over the summit in a vast fountain. Whenever this is seen, calm and bright as the weather may be, the fishermen know that rough weather is impending, and they account for the circumstance by the meeting of two under-currents. One of the most singular facts about the head is that it is all hollow—a vast cavern—with an opening seaward, and another, called the Blow Hole, about the size of a finger, on the land, which makes up for its want of size by its noise, which is very great, and most peculiar on a quiet day, when there is a ground swell. A curious and unearthly sound it is, like that of a mighty rushing wind proceeding from the interior of the earth, as if all the gnomes of the Hartz Mountains were busy at their work. The cause of the noise is this: a heavy sea breaks into the cave, driving before it all the air into one corner, where the orifice is situated; for, by listening at the hole, you can mark the approach of each wave by the increasing volume of air. Leland again mentions this. 'Ther is also a wonderfulle hole at the Poynt of Worme Heade, but few dare enter into it, and men fable there that a Dore withein the spatious Hole hathe be sene withe great nayles on it—but that that is spoken of water reuninge under the grounde is more lykely.'" The cave, as far as is known, has been entered only once, and that was on an extraordinarily calm day, when Beynon rowed a party of visitors into it. He had, however, very vague notions respecting its size, and his prevailing feeling seemed to have been satisfaction at getting safe out again.

Peaks, Passes, and Glaciers. By MEMBERS of the ALPINE CLUB. London: Longman and Co. 1859.

In the charming volume before us there are many scenes, incidents, and descriptions which might delight general readers more than those particulars which we shall here set prominently before our own. We have properly to deal with specialities, and however tempting even to ourselves the digression into the most flowery paths, the pathways of science are the routes we are conscientiously compelled to follow.

The opening chapter, "Peaks, Passes, and Glaciers," describes to us the passage of the Fenetre de Salena by a party of the Alpine Club, with the dangers and difficulties of its accomplishment, and their accompanying rewards of wild and magnificent scenery, and those wonderful atmospheric beautifications which seem to be locked up and cherished in those caskets of Nature's recesses to which only the most daring can reach the key.

Amongst the wild scenes in this expedition, we have a vivid portraiture of a night encampment on the inhospitable slopes of the alpine heights of Salena, where the party halted within a few yards of a glacier-torrent, whence, when the morning dawned, they gazed out "upon a scene of savage grandeur, for wildness and desolation almost without a rival, even among the Alps, of which the sole components are crag, precipice, snow, ice, and aiguille, combined in every variety of stern and awful grandeur." From this "citadel of winter," a short but arduous walk in the earliest morn brought the mountain-travellers into a "garden of summer," the grass beneath their feet fresh and moist, and almost dazzling to the eye with the brilliancy of its emerald green; hardly a stone's throw from them, "the rich valley of Ferret stretched out on either hand, studded with chalets, dotted with sheep and cattle, sparkling with cultivation, instinct with life and luxuriant beauty. The dark masses of the great chain bounding the valley on the south were clothed with wood and herbage nearly to their summits, and a thin veil of delicate haze which hung upon them, showed how great was already the power of the autumn sun." Even the glacier-torrents they had so lately left, now flowed behind a rising ground, so that not an object remained in sight to remind them of the desolate region of eternal frost they had so lately quitted.

The second chapter, by Professor Tyndall, gives an account of his ascent of the Col du Géant, in July, 1857, and, commencing with a not very satisfactory compliment to readers in general, about other engagements, refers to a six-weeks' examination of the Mer de Glace and its tributaries, assisted by Dr. Hirst, with a view to the investigation of the motion of the glacier, and the connection of the veined-structure of the glacier with the stratification of the névé. But no scientific information on these points is given, and the whole chapter, however nicely penned, is therefore reduced to little more than the mere personal adventures of a man and a boy for a day among the *seracs* of the Glacier du Gèant, one of the few instructive passages being the description of the ice-cascade through the defile formed by Le Rognon and the promontory of the Aiguille Noire.

The fourth chapter, by Mr. W. Matthew, contains several years' excursions amongst the mountains of Bagnes, and abounds in notices of the movements and aspects of the six great glaciers which pour their frozen streams into this fine valley, ploughing up the green herbage of the meadows before them in their slow but irresistible passage, or stranded there, insensibly melt away, leaving great ruinous heaps of rock or moraines as mementos in future ages of their past existence.

The description of the interrupted feast, in Mr. Hinchoff's excursion from Zermatt to the Val d'Anniviers by the Trift Pass, is not only amusing, but affords an excellent idea of the fall and scattering of great blocks of massive rocks from the mountain's side, as also of the process by which the debris of the moraines is originally accumulated.

Mr. Ball's visit to Zermatt in 1843, in some degree fills up the noticeable blank in Professor Tyndall's paper by some casual observations on Professor Forbes' statements, and by some intelligibly recorded facts and suggestions of his own. To these are added some new remarks upon the intensities of moonlight and early dawn at great heights.

One passage in Mr. Anderson's interesting descent from the Schreckhorn, so forcibly conveys the constant and perpetual degradation of the granite rock-masses of the higher peaks, that we think it quite worthy of quotation, as showing how great in aggregate result must be the effects of the frosts and other atmospheric influences which are uninterruptedly exerted at these great mountain-heights. He tells us in the descent of his party they saw nothing but bare rock. "There seemed no end to it. Once only I remember that the scene was varied, when a change took place in the mineral character of the rock, and we passed from the granite—too constantly disintegrated by the frost to permit of vegetation forming upon it—to a formation which, by its composition or the direction of its cleavage, is more capable of resisting that mighty leveller of the high places of the earth. There the cliffs were clothed with lichens of the most beautiful and varied colours, affording a charming relief to the eye."

The cause of such destructive inundations as those of 1852, in Switzerland and Savoy, is simply and intelligibly explained by Mr. Ball, in his expedition from the Grimsel to Grindelwald.

"I had," he says, "already been struck with the fact that on the Grimsel, and even on the Siderhorn, we had on the previous day encountered rain instead of snow, whereas on former visits, during bad weather, I had found deep snow at the Grimsel in August. The thermometer, during the preceeding thirty-six hours, had not fallen below 47 degrees Fahrenheit, showing that the current from the south, whose over-charge of aqueous vapour had caused the heavy rain of the last five days, had maintained a temperature unusually high, even for the height of summer. This was the real cause of those destructive inundations which made the month of September, 1852, long remembered in many parts of Switzerland and Savoy. Such inundations would be far more common if the enormous fall of rain in the lower valleys of the Alps were not neutralized by its being converted into snow in the region of the higher mountains and glaciers. The usual supply from this latter source is greatly diminished at such times, and though the small streams are swollen, the great torrents that issue from the glaciers are reduced to less than half their usual volume. But the case is very different when rain several degrees above the freezing point falls upon the great fields of ice and névé. The whole of it goes to swell the glacier-streams, and, moreover, the entire of its surplus heat is consumed in melting the ice and snow with which it comes in contact. After endeavouring to estimate the prodigious amount of water that, under such circumstances, must be carried down within a few hours into the principal valleys, I was not at all surprized when, a few days later, in ascending from Sallenches to Chamouni, I found bridge after bridge swept away—some of them seventy or eighty feet above the usual level of the water—and masses of stone and rubbish brought down, sufficient in one instance to bury a house and mill so completely, that only a small portion of the latter, and the roof of the building, remained projecting from the surface."

Chapter eleven, by J. F. Hardy, although not one of the most scientific, is nevertheless one of the most delightful, for its easy flowing style, in the whole book; and Mr. Bunbury's visit to the Col de la Jungfrau, affords an example of what can be seen by those who have either not the "head" and daring, or are too indolent and un-enterprising to attack the higher and more formidable peaks.

In the note appended to this chapter, the editor's suggestion that the plants which we find at great heights on small oases in the ice-region are the remains of a more abundant vegetation, which has dwindled to its present trifling proportions owing to the extension of the glaciers, is a novel and perhaps a valuable one.

Refreshing, indeed, at the end of the book comes Professor Ramsey's contribution to the "Peaks, Passes, and Glaciers."

There is an honest English bluntness of expression in his sentences which causes their truthfulness to fall with force upon the apprehension. All that we have previously read in the book amounts to little more than a modernized version of enterprizing ascents, by which the accomplishments of bag-wigged De Sausure and his attendants, in wading through snow-fields, or scrambling over precipitous mountain-slopes and crags, have been excelled and exceeded. Professor Ramsay takes the mind back to times remote, when the lords of creation were the great carnivora that preyed on the gigantic mammoths and herbivora who were then the chief inhabitants of the earth. He talks to us about the *old* glaciers of Switzerland and of North Wales. He makes us think about the age of the great frozen ice-masses by that one still sliding down the mountain sides of Switzerland; and he shows us the great moraine-heaps of rocks and boulders still encumbering the mountain-valleys of Wales. He produces evidences in the marks on the precipitous cliffs of the Alps of the ancient greater depth and wider extent of the still veritable glaciers; and he shows us in the mountainous regions of Wales, the *roches moutonnees*, the striations of the rocks, and the heaps of debris of British glaciers long since melted away.

There are still those who would speak of geology in disparaging terms; but the interest and point of this book is certainly concentered in this geological history of those mighty ice-mountains. Nor are these mere speculations; they are, indeed, true inferences, substantially built upon accredited facts.

The first part of his article opens boldly and to the point at once. "Every-one," says he, "familiar with the Alps is aware of fluctuation in the dimensions of the glaciers. It is recorded in the pages of Forbes, that since the year 1767, the glacier of La Brenva rose three hundred feet above its present level, and again declined; and the terminal moraines of the Rhone glacier, arranged concentrically one within another, bear witness to its recent gradual diminution. The great Gorner glacier of Monte Rosa, also, is even now steadily advancing, and is said within the memory of men not old, to have already swallowed up forty chalets and a considerable tract of meadow-land. But all such historical variations in the magnitude of glaciers are trifling compared with their wonderful extension in pre-historic periods. There is, perhaps, scarcely a valley in the High Alps in which the traveller, whose eye is educated in glacial phenomena, will not discern symptoms of the former presence of glaciers where none now exist; and in numerous instances, far from requiring to be searched for, these indications force themselves on the attention by signs as strong as if the glacier had disappeared but a short time before the growth of the living vegetation. So startling indeed, are these revelations, that for a time the observer scarcely dares to admit to himself the justness of his conclusions, when he finds in striations, moraines, *roches moutonnees* and *blocs perches* unequivocal marks of the former extension of an existing glacier more than a long day's march beyond its present termination; and further, that its actual surface of to-day is a thousand feet and more beneath its ancient level."

As it is with the glaciers of the Aar, which the professor selects as examples, so is it with many other alpine valleys, and so has it been in North Wales. After this follow interesting observations on the disappearance of moraines, the former state of the Grimsel, the Aletech glacier, the Kirchet, on the interesting question whether a glacier ever reached the Jura? and on the great perched blocks of Monthey, one of them twenty paces in length, and eight thousand or nine thousand tons in weight.

These blocks lie in great quantities in and upon sandy gravel roughly stratified, comparable more in their semi-angular character to the partially-rounded chalk-flints of our ordinary "drift" gravels. "Similar drift-like strata encircle the Lake of Geneva, rising high above its level, and thence range across the low lands of Switzerland, at the base of the Jura towards Zurich and Schaffhausen, covering the hills hundreds of feet above the level of the lakes of Zurich and Zug, each of which lies more than a hundred feet above the Lake of Geneva.

"If this view of the subject be correct," it is argued, "it follows that during part of the period when the North of Europe was submerged to receive the drift, Switzerland also lay beneath the sea, at least two thousand feet beneath its present level, that being about the height of the blocks of Monthey above the sea."

The ancient glacial phenomena of Switzerland are then shown to accord with those of North Wales; and the tract between the Snowdon range and the Menai Straights is described, in which we are favoured with examples of *blocs perches, roches moutonnees*, erratic blocks, polished and striated rocks, and moraines, by which the region of Snowdon is brought prominently before us as the site, in geological and pre-historic times, of mighty glaciers, of which the only evidences that now remain are the inscriptions they have themselves engraven, ages since, in their irresistible passage.

Snowdon, the highest and noblest mountain of the district, "is bounded on three sides by six vast hollows or valleys, which have been scooped out from time to time in the rock-masses of which the mountain is formed. In one of these, Cwm-glas, some of the most perfect remains of glacier-action are to be found in the form of moraine-debris and heaps of clay, boulders, and angular blocks identical in composition and in general aspect with the Swiss moraines."

Professor Ramsay then proceeds with others of these valleys describing their beauties and their evidences of ancient glacial phenomena, coming to the conclusion that Snowdon formed the centre of six glaciers having an ice-thickness generally of nearly five hundred feet, and that these flowed from the peak down those six lateral valleys we have already mentioned. From his own observations he estimates the greatest formerly attained thickness of ice at the Pass of Llanberis at from eleven hundred to thirteen hundred feet.

We are now introduced to another phase of the subject, the relations of the glacial drift to the glaciers. Everyone who has given any attention to tertiary geology is aware that a large portion of the low country of the North of Europe and a considerable portion of the British Isles are covered more or less by loose superficial detrital accumulations, containing large boulders and rocks which have been brought often many hundreds of miles from their original beds. These deposits are, as we might have presumed they would be, regarded by the Professor, according to the modern glacial theories, as the produce of melted icebergs.

This glacial drift rises to very considerable heights (upwards of two thousand feet, and containing shells at thirteen hundred feet) above the sea in this Snowdonian region; and much of it, though rudely stratified, resembles ordinary moraine-matter. From its arrangement in terraces it is considered to mark successive stages of elevation of the land in its emergence from the glacial waters; and that as the average height of the loftiest mountains could not during that era have attained more than from fourteen hundred to two thousand feet, the formation of glaciers upon them proves the intensity of the cold at that period. From these glaciers icebergs broke off at the sea-board, strewing the regions around in their dissolution with rock-boulders and drift-gravels.

Some remarks follow on the grinding and scooping out, by the glacier in its motion, of the hollows since converted into lakes and tarns; and the paper is concluded by some speculations on the possibility even of the eyes of man having gazed on those old glaciers of Wales.

A chapter on Etna and some suggestions for Alpine travellers finish this excellent and tasteful book, which we hope will have very many readers, for the reason that it can neither be read without interest nor without profit; and we are pleased to observe that a second edition is already called for.

Map of Hereford. By T. E. Curley, Esq., C.E.

We gladly notice this map, sent to us a short time since by Mr. Curley; for, although a local production, and consequently limited in its uses and application, it presents a step in a right direction, which, if followed out in like manner in other districts, would render material aid to a very extended and minute knowledge of the stratigraphic condition of these islands. Mr. Curley, engaged upon the drainage of the town of Hereford, has necessarily met, in the execution of the works he has been superintending, with numerous opportunities of acquiring an intimate knowledge of the rocks and soils of that town and its vicinity. Some of the information thus obtained, carefully worked out into two sections exhibiting the disposition of the gravels and local drift-beds on the adjacent new red-sandstone, have been added with good effect to the map. We hope other engineers will follow this excellent plan, and that, ere many years, all our town plans will have as much geological information appended to them. The practical value of such additions cannot be overestimated.

THE GEOLOGIST.

SEPTEMBER, 1859.

THE COMMON FOSSILS OF THE BRITISH ROCKS.

By S. J. Mackie, F.G.S., F.S.A.

(Continued from page 192.)

Chap. 4. *First Traces of the Succession of Life.—The Lower Silurian Rocks.*

How sweet the communing with oneself; the thoughts that rise and flee; the dreams of solitude, away from the busy hum of men—quiet—alone with God, thinking of His wonders and His powers, the beauty and skillfulness of His works. As late at night I sat at my open study-window gazing over the forest of roofs and chimneys of the sleeping city, with its towers and church-spires pointing to the holy heavens and star-lit sky, for the first time I heard the great bell of Westminster toll out the midnight hour—sonorous, solemn, slow, as if clinging with throbbing pulse and quivering frame to Time's flowing garments to arrest him in his sturdy march. Solemn and slow the changing hours of past creations have passed away, with no "Big Ben" to mark their passage; but solemn and slow has Time himself impressed his footsteps on the yielding sands of earth, and left us his own record of his onward course.

In this chapter we pass on to the first change of scene, and as we found it necessary, at the commencement of our work, to have a clear idea of the succession of the great rock-masses of which the fossiliferous crust of our globe is constituted, so we shall find it imperative for a right comprehension and a clear understanding of the succession of organic life upon our planet to have a knowledge of the great types upon which the various members of the animal and vegetable kingdoms are constructed, and which have been selected by naturalists as the principles on which to ground those arbitrary divisions and sub-divisions of scientific arrangement so necessary for facilitating the acquirement of knowledge and for the progress of investigation.

All animated or living things belong to one of two markedly distinct groups—the animal or vegetable; hence in scientific nomenclature the greatest distinctions are given to these thoroughly decided divisions, and they are consequently termed *kingdoms*. Taking either plants or animals it is apparent that of either we have many sorts, and also that these sorts are evidently constructed on different plans, as for example seaweeds and trees, insects, crustacea, starfish, shells, quadrupeds; hence we have principal divisions into *sub-kingdoms*, *classes*, and *orders*. Taking the members of any one of these divisions, we find that, though there may be a common resemblance on the whole, yet the typical form, upon which all of them are more or less constructed, is nevertheless variously modified, and that numerous forms, although subservient to the type, are still modelled more directly upon some certain deviation or peculiarity. For example, the class Mammalia has the characteristic features of the Vertebrata in the possession of an internal bony skeleton, consisting of a cranium, vertebral column, and two fore and two hind limbs for terrestrial locomotion. But how distinctly is this *vertebrate type* modified to suit the particular exigencies, habits, and conditions of other vertebrate classes, such as fish, reptiles, birds, whales, man. Each of these classes again displays many distinctive modifications, as, for example, the eagle and the sparrow, the herring and the shark; hence arise other subdivisions or *orders*, and these again exhibit subservient modifications, as for instance the eagle and the hawk. Those which have thus a great resemblance for each other are included in one *family*, and are distinguished from each other by a generic name, or in other words each family is made up of different sorts or *genera*. These again are susceptible of division by individual or special characters, whence the denomination of *species*, the still minor variations of which—brought about by difference of existence, physical conditions, or local circumstances—are indicated by the term *varieties*.

The first glance at the familiar objects around us assures us that all living things have not the same values of structure or the like capabilities of life. We perceive at once that some are of far lower grades both of intelligence and action; that in point of fact there is a scale of development of the social rank both of animals and vegetables. These conditions are so apparent and so well known that it would be useless to dwell upon them. We proceed therefore at once to mark out the divisions of the animal and vegetable kingdoms, and the particular characters by which each is indicated, premising that, as in the inorganic world there is no decided natural line of division between one rock-mass and the others, one stratum and another, in the *succession* of formation, and that what appears a break in the series in one place is filled up by some deposit in another, so in the organic world each genus, family, and order are so linked by modifications and divergences to others, that the actual lines of division are essentially arbitrary, and especially in the more minute scientific and natural divisions, as between species, genera, and families; the higher groups appearing, however, as far as our present knowledge extends, to be merely linked together by similitudes, or by the devarication of one type into an apparent resemblance to another rather than by any natural affinities between them.

We now present in Table I. the primary constituent members of these great divisions as nearly as may be in the ascending order of their organic development and rank, thus placing Man, the highest, at the top, and the Rhizopods—Protozoans at the base of the series. The groups of animal-forms must not be altogether regarded as indicating a progressive increased rank of organization; many of them are of equal value with each other, and the exact position of others has not been thoroughly determined. Moreover, no system of classification of organic forms, whether vegetable or animal, can be as yet regarded as perfect; the best can only be considered artificial and provisional, requiring many modifications and improvements; hence the student or general reader must not therefore be dismayed at the difference of position assigned by different naturalists to particular organisms, nor think that naturalists are ignorantly differing from each other in their ideas. Nor must they

I.—TABULAR VIEW OF THE PRINCIPAL DIVISIONS OF ORGANIC LIFE.

ANIMAL KINGDOM.

Sub-Kingdoms.

VERTEBRATA.

MAMMALIA *(Terrestrial conditions, except Whales)*.—Ex.: Man, Beasts, Whales.

AVES *(Birds)*.—Mostly adapted for aërial flight.

REPTILIA.—Mostly holding amphibious conditions.

PISCES *(Fishes)*.—Aquatic conditions.

INVERTEBRATA.

ARTICULATA *(Jointed animals)*.—Ex.: Insects, Crustacea, Worms.

MOLLUSCA *(Soft-bodied animals)*.—Ex.: Shell-fish.

MOLLUSCOIDEA *(Mollusc-like animals)*.—Ex.: Tunicata, Bryozoa.

RADIATA *(Radiated animals)*.—Ex.: Echinoderms, Zoophytes.

PROTOZOA *(Globular animals.)*—Ex.: Sponges, Foraminifers.

VEGETABLE KINGDOM.

Sub-Kingdoms.

PHANEROGAMS.

ANGIOSPERMS.—Ex.: Grasses, Palms, Flowering Plants, Trees.

GYMNOSPERMS.—Ex.: Conifers.

CRYPTOGAMS.

ANGIOSPORES.—Ex.: Mosses, Ferns, Lycopods.

GYMNOSPORES.—Ex.: Fungi, Algæ.

allow themselves to get confused with the variety of terms used by different authors to designate the same or nearly the same classes of animals or plants. Such differences are no more than the natural results of the attempts to found a perfect system of classification while necessarily beginning to make that effort with imperfect materials, which through many deficiencies in our knowledge present also great gaps and voids in the desired continuity of the order of arrangement of organized beings. By degrees such gaps are filled up in the progress of our investigations, and by the acquirement of additional knowledge of the structural character of known species, or the discovery of new forms.

Under the scientific classification presented in further detail in Table II., existing forms of animals can be more or less harmoniously arranged. It may be regarded as that generally received, the terms being those ordinarily in use by the principal writers; and in it we have included the latest revisions and amendments in the arrangement of the Mammalia by Professor Owen, whose indefatigable researches, skilful observation, and perspicuous deductions have long since placed him in the foremost rank of naturalists, whether past or present.

By him this most important class has been primarily grouped, according to the characters of the brain, into four principal divisions, which thus displayed also exhibit their comparative intellectual capacities.

For the complete grouping and arrangement of the animal and vegetable kingdoms it is necessary that all those fossil forms, often so widely different from those existant, which palæontology has added, and is still daily adding, to the fauna and flora of our planet in its completeness, should be included and brought into one and the same harmonious grouping. Thus does every new form exhumed from the great cemetery of the Past add some new link to or produce some fresh deviation from our latest and most complete results of arrangements. It is, however, not a little curious to find the relics of past ages supplying the gaps and deficiencies of the creation around us, and forming the links between what were previously considered aberrant and abnormal conditions; every step of progress adding to the beauty, harmony, consistency, and unity of the great plan of creation.

TABLE II.—GENERAL GROUPING OF THE ANIMAL KINGDOM.

Class I. MAMMALIA (Sucklers).

		Order.	Family.	Type-form.
ARCHENCEPHALA [*Over-ruling Brain*].		BIMANA *(Two-hands)*	*Homo* (Man)	Man
GYRENCEPHALA [*Convoluted-brain*].	UNGUICULATA *(Clawed)*	QUADRUMANA *(Four-hands)*	*Catarrhina* (Narrow-nose)	Monkey
			Platyrrhina (Broad-nose)	
			Strepsirhina (Screw-nose)	
		CARNIVORA *(Flesh-eaters)*	*Digitigrada* (Finger-walkers)	Dog
			Plantigrada (Sole-walkers)	Bear
			Pinnigrada (Fin-walkers)	Seal
	UNGULATA *(Hoofed)*	ARTIODACTYLA *(Even-toes)*	*Omnivora* (General feeders)	Pig
			Ruminantia (Cud-chewers)	Ox
		PERISSODACTYLA *(Odd-toes)*	*Solidungula* (Solid-hoofed)	Horse
			Multungula (Many-hoofed)	Rhinoceros
		PROBOSCIDIA *(Having a Proboscis)*	*Elephantida* (Elephant-tribe)	Elephant
			Dinotherida (Monster-beasts)	
		TOXODONTIA *(Bow-tooth)*	*Toxodontida* (Bow-tooth)	Toxodon
			Nesodontida (Island-tooth)	
	MUTILATA *(Short-limbed)*	SIRENIA *(Manatee-tribe)*	*Manatida* (Fore-fins)	Manatee
			Halicorida (Dugong-tribe)	
		CETACEA *(Whale-tribe or Aquatic Mammals)*.	*Delphinida* (Dolphin-tribe)	Whale
			Balænida (Whales proper)	

LISSENCEPHALA [*Smooth-brain*].	BRUTA *(Brutes)*	*Bradypodida* (Slow-feet) *Dasypodida* (Hairy-feet) *Edentula* (Tooth-less)	Sloth
	CHEIROPTERA *(Hand-wing)*	*Frugivora* (Fruit-eaters) *Insectivora* (Insect-eaters)	Bat
	INSECTIVORA *(Insect-eating)*	*Talpida* (Mole-tribe) *Erinaceida* (Hedgehog-tribe) *Soricida* (Shrew-tribe)	Mole
	RODENTIA *(Gnawers)*	*Non-claviculata* (Non-claviculate) *Claviculata* (Having a collar-bone)	Rat
LYENCEPHALA [*Diminished-brain*].	MARSUPIALIA *(Having a Pouch for Young)*	*Rhizophaga* (Root-eaters) *Poëphaga* (Grass-eaters) *Carpophaga* (Fruit-eaters) *Entomophaga* (Insect-eaters)	Kangaroo
	MONOTREMATA *(One-vent)*	*Echidnida* (Porcupine ant-eaters) *Ornithorhynchida* (Bird-beak)	Ornithorhynchus

Class II. AVES (Birds).

RAPTORES *(Seizers)*	Eagle
INSESSORES *(Perchers)*	Finch
SCANSORES *(Climbers)*	Parrot
RASORES *(Scrapers)*	Barn-door Fowl
CURSORES *(Runners)*	Ostrich
GRALLATORES *(Waders)*	Stork
NATATORES *(Swimmers)* or PALMIPEDES *(web-footed)*	Duck

Class III. REPTILIA (Crawlers).

Order.	*Family.*	*Type-form.*
Sauria (*Lizard-tribe*)	*Dinosauria* (Monstrous saurians)	Iguanodon
	Enaliosauria (Sea-saurians)	Ichthyosaurus
	Loricata (Mailed), *or Crocodilia*	Crocodile
	Squamata (Scaled), *or Lacertilia*	Lizard
	Pterosauria (Winged Saurians)	Pterodactyle
Chelonia (*Tortoise and Turtle-tribes*)		Tortoise
Ophidia (*Serpent-tribe*)		Common Snake
Batrachia (*Frog-tribe*)		Frog
[Labyrinthodontia (*Maze-tooth*) Type-form, Labyrinthodon]		

Class IV. PISCES (Fishes).

PLACOIDEI (*Plate-scale*) *of Agassiz.*	Plagiostomi (*Oblique-mouth*)		Shark
	Holocephala (*Solid-head*)		Chimæra
GANOIDEI (*Sheen-scale*) *of Agassiz.*	Protopteri (*First-, or simple-fin*)		Lepidosiren
	Ganoidei (*Glittering-*), or Goniolepidoti (*Angular-scale*)		Lepidosteus and Sturgeon
	Lophobranchii (*Tuft-gill*)		Hippocampus
	Plectognathi (*Sewn-jaws*)		File-fish
Partly CYCLOIDEI (Circle-scale) and partly CTENOIDEI (Comb-scale) of Agassiz.	Acanthopteri (*Spine-fin*)		Perch
	Anacanthini (*Spine-less*)	*A. Jugulares* (Fins on throat)	Cod
		A. Apodes (Foot-less)	Ophidium
	Pharyngognathi (*Gullet-jaws*)	*P. Acanthopterygii* (Spine-fins)	Wrasse
		P. Malacopterygii (Soft-fins)	Saury-pike

CYCLOIDEI *(Circle-scale) of Agassiz.*	MALACOPTERI *(Soft-fin)* [PHYSOSTOMI *of Müller*].	*M. Abdominales* (Ventral fins behind pectoral)	Herring
		M. Apodes (Without ventral fins)	Eel
	DERMOPTERI *(Back-fin)*	*Marsipobranchii* (Purse-gills) or *Cyclostomi* (Circle-mouth)	Lamprey
		Pharyngobranchii (Pharynx-gills) or *Cirrhostomi* (Fringe-mouth)	Lancelet

Class V. MOLLUSCA (Soft-bodied Animals).

CEPHALOPODA *(Feet placed around the head)*	Cuttle-fish
GASTEROPODA *(Belly-foot)*	Snail, Whelk
HETEROPODA *(Other feet)*	Carinaria
PTEROPODA *(Wing-foot)*	Clio
ACEPHALA *(Head-less)*	Oyster
BRACHIOPODA *(Gill-feet)*	Terebratula

Class VI. MOLLUSCOIDEA (Allied to Molluscs).

BRYOZOA *(Moss-animals)*	Flustra
TUNICATA *(Tunic-coated)*	Ascidium

Class VII. ARTICULATA (Jointed Animals).

INSECTA *(Insects proper)*	Beetles, Moths, Flies
MYRIAPODA *(Myriad-feet)*	Centipedes
ARACHNIDA *(Spider-group)*	Spider

Class VII. ARTICULATA (Jointed Animals) (Continued).

	Order.	*Family.*	*Type-form.*
Crustacea	Malacostraca *(Soft shell)*		
	I. Podophthalmia *(Pedicle-eye)*—		
		Decapoda (Ten-feet)	Crab
		Stomapoda (Mouth-feet)	Squill
	II. Edriophthalmia *(Sessile-eye)*—		
		Amphipoda (Double-feet)	Gammarus
		Læmipoda (Throat-foot)	Caprella
		Isopoda (Equal-feet)	Oniscus
	Entomostraca *(Shelled insects)*		
	I. Lophyropoda *(Crest-feet)*—		
		Copepoda (Oar-foot)	Cyclops
		Ostracoda (Shelled)	Cypris
	II. Branchiopoda *(Gill-feet)*—		
		Cladocera (Branch-horn)	Daphnia
		Phyllopoda (Leaf-foot)	Limnadia
	III. Poecilopoda *(Various feet)*—		
		Limulidæ (Kingcrab-tribe)	Limulus
		Eurypteridæ (Wide-fin)	Eurypterus
	[Trilobita *(Three-lobed)* Type-form, Trilobite]		
	IV. Siphonostomata *(Siphon-mouth)*		Lernæa
	[Cirrhipeda *(Lash-feet)* Type-form, Barnacle]		
	[Rotifera *(Wheel-bearers)* Type-form, Rotifer]		
Annelida *(Ring-form)*		*Dorsibranchiata* (Back-gilled)	Sea-mouse
		Tubicolæ (Tube-inhabiting)	Serpula
		Terricolæ (Earth-dwellers)	Earthworm
		Suctoria (Suckers)	Leech

ANNELIDA *(continued)*	*Turbellaria* (Ribbon-worms)	Planaria
	Entozoa (Intestinal-worms)	Tape-worm

Class VIII. RADIATA, (Ray-form Animals).

ECHINODERMATA *(Spiny-skin)*	*Echinoidea* (Urchin-like)	Echinus
	Asteroidea (Star-form) or *Stellarida*	Star-fish
	Crinoidea (Lily-form)	Encrinite
	Sipunculida (Siphon-worm)	Sipunculus
	Holothurida (Sea-cucumber)	Holothurium
ACALEPHA *(Sea-nettles)*	… … … … … … … … …	Jelly-fish
POLYPIFERA *(Polype-bearing)* or ZOOPHYTA *(Animal-plants)*	*Sertularida* (Hydroid polypifers)	Sertularia
	Corallaria (Coral-animals) or *Zoantharia* (Animal-flowers)	Madrepore
	Actinoidea (Helianthoid corals)	
	Actinida (Soft-bodied corals)	Sea-Anemone
	Alcyonaria (Asteroid polypes)	Alcyonium

[GRAPTOLITES *(Stone-pens)* Type-form, Graptolites]

Class IX. *PROTOZOA (First or Simplest Animals).*

[VENTRICULITES *(Bag-stones)* Type-form, Ventriculite]

SPONGIDA *(Sponge-tribe)*	*Siphonida* (Siphon-sponges)	Siphonia
	Amorphospongida (Amorphous sponges)	Common Sponge
RHIZOPODA *(Root-foot)*	*Amœbida* (Changeful)	Amœba
	Thalassicolidæ (Ocean-dwellers)	Thalassicola
	Polycystinea (Many-celled)	Rhopalocanium
	Foraminifera (Hole-bearers)	Cristellaria

We proceed now to detail the chief characters of each of the above great groups, beginning with the lowest, and the type-plans on which they are constructed. To say what is the lowest form of animal-life is indeed difficult, as it is also of the vegetable. We have certain moving and apparently living cells and frustules, such as the monads, diatoms, and other organisms, commonly termed (from their usual presence in vegetable infusions and stagnant water) Infusoria; but the discussion is still strong as to their proper position, although the stronger evidence is at present on the side of those who group them with the vegetable kingdom. At all events the minutest and simplest forms of organized objects are simple cells; and as all animals and vegetables, whatever their rank, are built up of an organic structure composed of cells, it is at least difficult to determine either the identity with each other of such primitive cells; the commingling in them of the rudimentary stages of both kingdoms; or from their smallness, delicateness, and similarity of chemical composition and their structural resemblances, to point out the essential distinctions.

These primitive cell-forms, too, possessed of no solid parts, and liable to almost instant decay after death, enter not into the domains of palæontology; and it is only in the case of the diatoms and siliceous or calcareous loricated (shelled) forms that we find any traces in a fossil state. These, however, are found in such abundance in some of the later Tertiary deposits as to form whole beds, which are, as in the case of the Tripoli and the Berg-mehl, used for industrial or domestic purposes. But as these belong, according to most authorities, to the vegetable tribes, we shall notice them more fully under that head and when we come to treat in the progress of our work of the Tertiary rocks.

The first class then which we notice of the Protozoa are the Rhizopoda or *root-foot* animals. The Protozoa are all more or less *globular* or amorphous; for even the sponges or Porifera have generally a spherical shape, although in some genera of this higher group the true globular form is indented into funnel-shaped cavities or elongated into tubular stems. In the lower group recognized in the fossil-state by the innumerable shells of Foraminifera, abundant in many rocks, but best known in the

Secondary and Tertiary formations, the animals, although they put on nautiloid or Nautilus-resembling forms, are not truly such chambered shells as those of the cephalopod, but are in reality a congeries of either constricted, flattened, or inflated globular minute masses of shell-covered jelly-like flesh, or *sarcode*, which are so congregated together by the natural imperfect self-division or fissipartition of one from the other. The original animal consists of a mere little globular mass, apparently without nerves or organs of nutrition or digestion, the enveloping cuticle of which hardens into a calcareous, horny, or siliceous shell, full of minute pores, through which the sarcode is protruded in fine threads for the purposes of prehension or locomotion.

At the period of growth or self-division this sarcode is exuded and forms a second globule, the containing cuticle of which hardens in the like manner into an enveloping shell, but which remains attached on the side whence it was exuded to the parent globule. These repeated exudations take place on more or less regular plans; sometimes each overlaps the other to form a nautilus-like foraminifer; sometimes they are developed in a straight line or a continuous slight curve; sometimes the arrangement is spiral; sometimes on a flat plane; and sometimes commencing in their young state on one plan, they are continued on to their adult state on another.

From the Foraminifera we ascend to the sponges, still gelatinous animals, but having an internal support of horny, calcareous, or siliceous threads or spines (spicula), and also inhalent and exhalent channels for the in-draught and expulsion of currents of water, by which means the sustenance of the sponge is obtained.

The next class in the scale of animal-life shows a structural plan of a radiate or star-like character. There is a central plate, point, or cavity whence the parts of the organism radiate, like the spokes of a wheel from its nave. This is seen in the polypi or coral-animals, the sea-anemones (Actinia), and the hydras of our ponds. We see the like type-form in the jelly-fish and little balloon-like Beroes (*Cydippe pileus*); and we see it also in the sea-urchins and star-fish, and in the fossil crinoids or lily-animals.

In the Articulata, the typical form of structure is that of jointed segments or rings, as we observe in the common earth-worm and the leech, and in the various modifications offered in the lobster and crab-tribes, the spiders, the centipedes, and ordinary insects, as beetles, moths, and flies.

All these classes (termed, as a whole, Invertebrates) are remarkable for the absence of any *internal* skeleton or support, except in the cuttle-fish, the "pen" or solid plate of which is internal, although not approaching the character of a framework of bones, while the animal is otherwise, through the nautilus thoroughly identified with the more usual characters of the mollusca.

Between this class and the true Mollusca are certain animals which possess more or less similar parts and organs to the shell-fish proper, but which yet differ from them in either being seated in cup-like cells linked together by a horny or calcareous stem, or in being enveloped in a bag-like skin or tunic, and in being divested of any proper shell. These are termed Molluscoidea, or Mollusca- (shell-fish) resembling animals. Such are the Bryozoa or moss-like encrusting-animals—Flustra, Eschara, Plumatella, &c., and both the simple and the compound Ascidians or Tunicata.

In the Mollusca (soft-bodied animals) or shell-fish are included very considerable ranges of development in the rank of organic life. All possess a stomach, nerves in the form of ganglionic cores and threads, organs of digestion, and more or less of locomotion, and a single (univalve) or double (bivalve) solid calcareous shell. Some, the lowest in grade, are headless, as the oyster; others are of high organization, and approach towards the fishes, namely, the Cephalopoda, or cuttle-fish.

The next great division of the animal-kingdom, which we now approach, is characterized on the contrary by the possession of an internal framework of osseous supports or bones, and especially of a continuous series of a particular form, *vertebra*, connected together by muscles and ligaments into a vertebral column or back-bone, as it is familiarly termed. This vertebral column is cartilaginous and almost rudimentary in some fishes, while in others it is comparatively solid and bony. In the Fish-tribe the whole column is adapted to flexible motion, generally lateral or from side to side, and the ribs, skull, and fins are also modified for the free propulsion of the creature through the water, the medium in which it is destined to pass its existence.

From the fish we pass upwards to the Reptiles, in which we have a considerable advance of organization, and the first decided traces of fore and hind limbs or legs for terrestrial or amphibious locomotion. The heart of reptiles has but one ventricle, and the circulation of their blood is sluggish and slow; and indeed their whole organization is far inferior to the animals of the next and highest class of animals, the Mammalia.

In these last the blood is warm; the heart is possessed of auricles and ventricles; the circulation free and rapid; and the internal skeleton of the highest perfection of development. At the top of the class stands man, the most intellectual and most highly organized of all created things.

GENERAL CONSIDERATIONS ON THE FORMATION OF ORE-VEINS.

(*Translated from the German of* PROFESSOR BERNHARD COTTA, of Freiberg, *with an Introductory Notice on the Study of Mineral Veins and Metalliferous Deposits, by* H. C. SALMON, ESQ., Plymouth.)

I PROPOSE, from time to time, in the pages of this magazine, to bring before geologists and geological students translations or abstracts of some of the most authoritative memoirs of foreign geologists on the subject of mineral veins and metalliferous deposits.

Notwithstanding the great commercial value of the metallic mines of the United Kingdom, the subject of mineral veins and metalliferous deposits has not, of late years, occupied the serious attention of many men of recognized scientific position in this country: the late Sir Henry de la Beche, Mr. W. Jory Henwood, and Mr. Warington Smyth are those best known. The strong distaste which undoubtedly exists to inquiries in this field of geology is due to many causes which it would be out of place to discuss here. I may nevertheless be permitted to say that, however just this feeling may have been in its origin, a continued shrinking from all attempts to grapple with the difficulties which admittedly beset this subject is likely to retard the progress of some of the most important branches of chemical and physical geology. The successful solution of many obscure problems can only be hoped for from a long, patient, and accurate examination of the never-ceasing processes of nature working deep in the recesses of the earth, and which are only open to observation in those wonderful excavations which, by the patient toil of years upon years, have been made accessible to us in our mining districts.

The history of science teaches us that the prevalence of speculation (theorising) is generally in inverse ratio to that of observation. When correct facts are few, the vaguest speculations are the most in vogue. The subject at present under our consideration forms no exception to this experience. While our knowledge of the *facts* of metalliferous deposits seems, to me, to have remained almost stationary for the last generation, the same cannot be said of speculations, or so-called theories, as to their origin. These have been abundant enough; but although they form an injurious and retarding element to the progress of true information, they do not stand alone, nor I believe pre-eminent, in this respect. The great evil connected with this subject is a tendency to state as *facts* what are in truth often nothing but *opinions*—and probably very incorrect opinions: "d'illusions systématiques qui nous porteraient à considérer comme des faits positifs ce qui n'est encore que dans le vague des conjectures."* The grave errors arising from this cause are, I am satisfied, far greater than are at all suspected. On future occasions I shall take an opportunity of referring to some that have come under my own observation.

If we now turn to the Continent we find, if not a very brilliant advance, yet a certain and steady progress both in observation and generalization. This of course is almost entirely due to the existence, in the principal continental states, of educated mining corps, under whose immediate superintendence all operations must be carried on—the government whom they represent being in most cases the proprietors of all mines and minerals in their respective countries. In France, in Germany, in Russia, and in other states, a very extensive and a very high-class literature is devoted to the subject; and the result, if not equal to what English energy would produce *with the same means*, at least surpasses, a hundred-fold, anything we *do* possess. Among these, the German mining literature, as might be expected from the countrymen of Werner, stands preeminent; and is particularly valuable from its characteristic minuteness, and also from the great and accurate mineralogical knowledge of the German engineers.*

---

* Fournet, "Etudes sur les dépôts métallifères," p. 385.

As I am strongly convinced of the importance of the study of mineral veins, not merely for useful purposes, but also in a purely scientific point of view, it has struck me that the publication, in an accessible form, of some of the most considered of these observations and disquisitions would afford a secure basis as to facts, and a worthy guide as to opinion, invaluable as an aid to the student who, quitting the more beaten paths of palæontology, may venture to enter upon the as yet almost unfrequented road to distinction offered by the exploration of the mineralogical, chemical, and physical departments of geology, of which the inquiry into the circumstances of the origin of mineral veins is undoubtedly one of the most important.

In selecting memoirs for translation or abstract, I shall take particular care to include those which represent the distinctive schools of opinion. Professor Cotta's memoir which follows is generally considered to be the most compact exposition known of the hypothesis which it sets forth.

As loose and inaccurate language is fatal to satisfactory investigations of any branch of science, and as the nomenclature of mineral veins abounds with this looseness and inaccuracy, I take the present opportunity of giving a few definitions on the subject, which I shall continue as occasion may require.

---

* In instituting a comparison between English and foreign mining literature I am not unmindful of the publications of the Geological Survey. The most valuable of these, relating to mining subjects,—Sir H. de la Beche's memoir on South Wales, and that of Mr. Jukes on the South Staffordshire Coal-field—do not relate to metallic veins, and are consequently excluded from the scope of my observation. This leaves Mr. Warington Smyth as the only Survey writer on metalliferous deposits. His papers are, with those of Mr. W. J. Henwood, about the only modern ones of much value that we possess; for they are the result of *real* observation, and not mere industrious collections of hearsays.

DEFINITIONS RELATING TO VEINS AND METALLIFEROUS DEPOSITS.

I. English miners commonly say that such and such a rock *contains no mineral*, meaning thereby that it contains no metallic mineral, or mineral of the useful metals. As all rocks consist of minerals, of course such an expression is incorrect. In speaking of the minerals of the useful metals they should be described as *metallic minerals* or *ores*.

II. As all rocks consist of minerals, it is evident, when the expression *mineral-vein* is applied exclusively to those veins containing *ores*, that such limitation is also incorrect. Mineral-veins are universal in every formation, but ore-veins only are generally valuable to man. Rock-veins also occur. The following are definitions of these three classes of veins:—

ROCK-VEINS are fissures filled up with such mineral aggregates as also occur in large masses as rocks; as for example, granite, elvan, greenstone, or sandstone.

MINERAL-VEINS, on the other hand, are fissures filled up with minerals, or combinations of minerals, such as do *not* occur as *rocks*; as for example, crystallized fluor-spar, baryte, quartz, &c.

ORE-VEINS are either *mineral-veins* or *rock-veins*, in which ores are always present.

III. From these definitions it appears that ores may occur in rock-veins as well as mineral-veins. They may also occur in *rock-masses* which are not veins, but may be *beds*, or *stocks*, which latter is the German word for an ore-containing rock-mass that is neither a vein nor a bed. Stocks are divided into

STANDING-STOCKS, irregular ore-containing rock-masses with something vein-like in their character;

LYING-STOCKS, the same, with something of a bed-like character.

BEDS are accumulations of ore, or of rock-masses containing ore, lying parallel to the stratification in stratified rocks.

IV. The expressions *mineral-veins* and *metalliferous deposits* are not identical. The latter is applied to all ore-containing deposits, whether the ore be in rock-veins, mineral-veins, beds, stocks, or irregular and undefinable masses; while the term mineral-vein is always used within the strict limits of the definition.

V. The study of mineral-veins has a geological interest in no wise depending on those veins containing ores; and the study of the distribution of the ores of the useful metals, in whatever form they may occur, has a scientific interest quite distinct, and of a different class, from that of mineral-veins. The study of mineral-veins, and the study of metalliferous deposits, are consequently not identical pursuits; yet they are very nearly allied, inasmuch as by far the greater mass of metalliferous or ore deposits do occur in mineral-veins.

GENERAL CONSIDERATIONS ON THE FORMATION OF ORE-VEINS. From the German of BERNHARD COTTA, Professor of Geognosy at the Mining Academy of Freiberg.*

The formation of ore-veins should not, in any case, be regarded as an isolated phenomenon; it is intimately connected with the formation or metamorphism of certain rocks, and is only a particular, or special, effect of certain geological causes.

It was a very general and not unnatural mistake of the early investigators in the modern school of special geology that, freed from the general and vague hypotheses on the formation of the earth prevalent in the past century, and having their attention concentrated on the observation of isolated geological phenomena, they should consider and endeavour to account for them as being independent of each other and without any necessary connection. The explanation discovered or devised to account for one particular case was believed to be applicable to all others in any measure analogous to it. The consequences were, on the one side, too sharp a separation of special branches, and on the other, too great a striving after large generalizations. As they endeavoured to explain the origin of *one* ore-vein without reference to the incidents of its particular locality, so they would have it that all ore-veins, without distinction, originated in a similar manner. Indeed, some of the latest and most eminent writers on this subject have fallen into this mistake. It almost appears as if they had forgotten that the expression *vein* only distinguishes the *form* of an occurrence, by no means its *nature*; and that particular species of ores (native metals, sulphides of metals, oxides and hydrates) are found in veins with very varied combinations, and under very diverse circumstances.

---

* Gangstudien, Vol. I., p. 85.

Another mistake of early geologists was that they were always prone to consider geological events as caused by a wholly peculiar state of things belonging to an anterior world concluded with the appearance of man. This doctrine was but too favourable to the growth of the most unsound and groundless hypotheses. Nothing was at that time impossible in the eyes of geologists; they had no regard to the analogies of existing causes; scarcely much indeed for the essential laws of nature. It was chiefly Sir Charles Lyell who successfully combated this doctrine. He showed that the magnificence of the result was extraordinarily heightened by the permanency of the causation; and that we had not necessarily to assume new sets of causes, different from those now in action, in order to account for the earth's surface as we now see it. According to this geologist, existing causes acting through periods of unlimited duration are sufficient to explain all geological phenomena. But he and his school have evidently carried this doctrine to an extreme, since he insists that there exists no recognizable proofs of any progressive development in the state of our earth, only a constant metamorphism; while an immense mass of facts affords very strong evidence of a *progressive development* of the earth, arising from its continued gradual cooling. Of these, I shall here merely point to the very remarkable differences in composition and structure that exists between the older and newer eruptive rocks, and to the succession of the various types of organic life recognized by fossil remains. This succession most undoubtedly leads, by its convergence, to a vanishing point, when as yet there existed no organic life on the earth.

The acceptance of the doctrine of a gradual development of the earth by slow cooling is supported by many facts, and suffices to explain the totality of geological phenomena and the general formation of the solid crust of the earth, although isolated cases of obscurity still remain.

Assuming, consequently, this mode of development, I shall now endeavour to throw a passing glance at the peculiar processes of vein-formation in general. In the present state of science of course such an assumption is to a great extent a mere matter of belief; but, believing it, we cannot, although it may be incapable of absolute proof, wholly banish it from science. If we take it only so far as it is supported by facts, and always bear steadily in mind that beyond that it is merely hypothetical, the assumption cannot be productive of disadvantage. On the other hand hypotheses have their use, if we do not absolutely and blindly resign ourselve to them, since they challenge further confirmation, and thereby lead to investigations in definite directions.

I shall consequently here endeavour to give a general geological explanation of ore-veins, without particularly specifying the grounds upon which it is based. These I shall pre-suppose as generally known and recognized, and shall only in some cases, where I deem it necessary, go into a nearer examination.

With the exception of some, consisting almost wholly of ironstone, we find ore-veins pre-eminently in the older rocks. Most frequently in the crystalline schists (gneiss, mica-slate, &c.); in ancient eruptive formations, as granite, syenite, greenstone, porphyry, &c.; in grauwacke formations; and as far as the Magnesian-limestone (Zechstein). Rarely, on the other hand, in the newer sedimentary formations; in such they occur in the Muschelkalk and Lias at Milhau, in the south of France, and in Chili and Algiers in members of the chalk-formation. Their occurrence is equally rare in trachytic, basaltic, or phonolitic rocks.

Like the old crystalline rock-masses, the veins are in general found in mountain districts, not in plains, and very usually in connection with these rocks—granite, greenstone, porphyry, &c., which for the most part are penetrated by them.

These general facts point to a certain connection between the older eruptive rocks and ore-veins, to which Fournet also, in a treatise translated by me, specially directs attention. But the probability of such a co-ordination is much increased by the circumstance that, at least in Germany, the relative age of these eruptive rocks is almost the same as that of the ore-veins, that is, they both belong to one great period. Here also they only in general penetrate the sedimentary formations as far as the Magnesian-limestone, into which certainly ore-veins have more frequently penetrated than have granite, porphyry, or greenstone.

Now if we examine these old crystalline massive rocks somewhat more closely, we find that they contain, tolerably often, the elements of ore-veins as accessory mixtures, or chemically combined with their essential constituents. These (metal-contents) usually increase with the diminution of the volume with which the rocks project on the earth's surface. Where the latter occur in great masses they are then mostly very free from metallic particles, or only contain them on their contact edges and in their small stock- or vein-formed ramifications. The following may serve as examples: the Zinnstockwerke of Altenberg, Zinnwald, Geier, &c.; the ore-containing greenstones of Schwarzenberg; many magnetic-iron stocks, and ore-containing porphyry-veins. Indeed, the outer solid crust of massive rocks seems often to be richer in metals than the regions lying beneath it; and from the destruction of such a crust may have been derived the rich stream-works, which are or have been found in districts where in the contiguous rock scarcely a trace of tin-ore can be discovered, as for example in the granite country at Weissenstadt in the Fichtelgebirge.

Can we not, under these circumstances, suppose the massive rocks to be the original bearers of the metal contents of ore-veins? It is a supposition which can be brought into the most beautiful harmony with the theory of the cooling of terrestrial bodies. Of course, provisionally, it can be nothing but a hypothesis. But let us endeavour to build further on this hypothesis, and by means of it to explain certain facts. Of course we must guard ourselves, in doing so, from subordinating and accommodating the facts to the hypothesis; the hypothesis must rather be modified to suit the facts, and if not it must be abandoned.

Let us likewise assume, also provisionally, an original distribution of the elements of ore-veins in the crystalline massive rocks, that is, in the eruptive portions of the original fluid nucleus, and let us see how this assumption suits the facts. Where these rocks occurred in great masses, they cooled very slowly, with the exception of their outer edges and upper crusts. In consequence of which the heavier and more fusible particles (in comparison to the rest of the mass) which were not chemically combined, had time to sink to the bottom, somewhat as in our blast-furnaces; and this may be the reason why the great masses of the eruptive rocks contain rich metallic mixtures in the highest degree at their rapidly-cooled contact-edges and upper crust. Similarly, in the small stock- or vein-formed ramifications of great masses the cooling supervened more quickly, so that the metallic particles in them frequently not having time to sink down, solidified simultaneously with the mass; and the same holds good also, in a certain degree, for many of these massive rock-veins which are to be considered as the pressings-up of the still fluid under-regions into the already consolidated upper-parts. In fact, veins of granite in granite, syenite, and granulit oftener contain metallic particles, particularly magnetic-iron ore and pyrites, than those great rock-tracts themselves; so that it is tolerably equal whether they penetrate merely the solidified crust of their mother-rock, or that of the neighbouring rock, only that in the latter case their cooling may have supervened more quickly.

The smaller masses, or stocks, of granitic rocks are particularly distinguished by containing tin-ore. This ore, as well as its usual companion, wolfram, lies partly finely distributed in the mass of the rock (granite, greisen, porphyry,) and partly crystallized out into fine reticulated contraction-fissures, which were probably generated by cooling before the constituents were all solidified. Quartz, chlorite, mica, and tourmaline are crystallized out with these ores; and if these small ore-veins contain, at the same time, here and there, galena, apatite, blende, or asphalt, fluor-spar, iron-spar, arragonite, or a second quartz deposition, and stolzite or lead-salts, then these were evidently not formed until afterwards, by sublimation or infiltration, or generated by a partial change of existing constituents. But when the deeper regions of these particularly rich metallic stocks, in which, in spite of the rapid cooling of the surface, still more metallic particles had accumulated than on the superficies, and remained longer fluid on account of their easier fusibility, became again eruptive or injective, that is, penetrated into the fissures of the former solidified or of the neighbouring rock, they could then form compact tin-holding ore-veins (like those at Ehrenfriedersdorf in Saxony) in and near the stock-formed masses.

We here see four or five modes of vein-filling in connection with one principal event—the eruption of a crystallized massive rock: they are, crystallization out of the yet soft neighbouring rock, sublimation, infiltration, alteration, and injection in a hot fluid condition; and many of these modes of filling up are found combined in one rock-fissure.

Similarly situated to these tin-containing granites are the ore-containing greenstones in the neighbourhood of Schwarzenberg in Saxony, only the latter are mostly pressed into narrow parallel fissures in the slate, and are therefore, although not more important, much richer in metal than the former. I think I have already, in 1833, sufficiently proved their injective origin.* In them also the sublimation-, infiltration-, and alteration-products are added to the original injected vein. When we find, in the same neighbourhood, greenstone-veins as free from ore as the others are rich in it, we must remember that the circumstances of the injection and cooling may have been extremely different.

It is a distinguishing feature of all these plutonic injective and secretion veins that their mineral species (which they contain) are never carbonates, fluor-spar, or baryte, but hornblende, augite, garnet, quartz, mica, and felspar, and such other minerals as usually occur as constituents of massive rocks.

The porphyry-veins also, in the environs of Freiberg, contain manifold ores. In the vein which passes near the Muldener Hütte, pyrites is found thickly sprinkled; and in a new quarry opposite this same Hütte there are a number of druses and vein-like cavities in the porphyry, covered with coatings of pyrites, galena, blende, calcspar, and baryte. These same minerals occur here not only in lenticular clefts and fissures, but also entirely enclosed as small nests in the porphyry, to which they evidently most intimately belong. Similarly, the porphyry-veins of the Nonnen- and Fursten-waldes at Kl. Waltersdorf are interpenetrated with many ore-holding quartz-branches.

---

* Erläuterungen zur Geogn., Karte von Sachsen, Th. II, S. 217—246.

At Hutte, two leagues from Freiberg, on the edge of the Tharander porphyry-mass, and in an isolated stock-form mass, galena, blende, and pyrites likewise occur in drusy vesicles of the porphyry, and gold is even said (although not on entirely reliable authority) to be found in the pyrites. But what are particularly and indisputably important for our considerations are the ore-holding felsite-rock or porphyries in the neighbourhood of Bräunsdorf, near Freiberg, which H. Müller has investigated and especially described in this volume.

Now is it not, at all events, a very remarkable circumstance that in the eruptive porphyry-formations of the environs of Freiberg the same ores and minerals occur disseminated which entirely prevail in the ore-veins of the same neighbourhood? Certainly, these ore-veins are in general of more recent origin than the porphyries, which they almost everywhere penetrate. But H. Müller has shown that, at the Reinsberger Glück Mgg. of Emanuel Erbstolln, the oldest Freiberger ore-veins, those of the great quartz-formation, are also penetrated and disturbed by certain porphyries, and that consequently both formations—ore-veins and porphyries—belong to one epoch, in the sense that the filling-up of the ore-veins in general is to be considered as a consequence of the porphyry-eruptions.

A new set of statements or a novel experience can never be supported by too many facts. I shall therefore here again cite that the dolomitic limestone, which at Tharander lies in the oldest clay-slate, sometimes contains, exactly at the point where it is disturbed by the porphyry, crystals of pyrites, copper-pyrites, galena, blende, and baryte, in drusy vesicles. May we not suppose that the occurrence of these minerals here is conditional upon the contiguity of the porphyry, as in the Freiberger ore-veins?

As volcanic activity on the land or at the bottom of the sea really by no means consists merely in the pressing-up of lava, but is most intimately connected with great earthquakes—the opening of fissures, the exhalations of gas and vapours, and the production of hot and mineral springs—so it is also certain that the pressing-up of the older massive rocks was combined with like complicated events. And if, in those earlier periods of geological time, we are entitled to assume the existence of a thick heavy atmosphere, and, as a consequence, at the level of the sea itself a higher boiling point of water, coupled with a generally higher temperature of terrestrial bodies, it must follow that the dissolving power of water was extremely heightened, as indeed is even now the case in deep fissures and under high pressure, as for example in the geysers of Iceland.

Under such circumstances it would be possible that the water dissolved not only *quantitatively* but also *qualitatively* far more constituents than is at present the case, and especially than we can dissolve in our laboratories. In consequence of the general higher temperature of the earth, it was at the same time possible that the water could raise these dissolved ingredients to a higher level than at present. G. Bischoff has shown that the constituents of those class of ore-veins which in their composition resemble those at Freiberg are soluble in water under certain circumstances and in certain combinations. With reference to this, I think we can place the most implicit confidence in the excellent memoir on the subject in Leonhard and Bronn's "Jahrbuch," 1844, p. 257, although I cannot share the opinions founded thereupon as to the infiltrative formation of *all* ore-veins. I must admit, however, that Bischoff has proved the possibility of the infiltrative filling-up of such ore-veins as those of Freiberg. It is required, therefore, on this subject only to show that the hypothesis is in harmony with the independent facts and with the foregoing remarks. The first can only be done step by step in this volume, the last I shall proceed at once to investigate.

A necessary consequence of the inequality of the temperature in the deeper and higher regions or zones of the water-filled fissures or fissure-systems must have been a constant circulation of water. That which at a great depth it dissolved out of the heated eruptive rocks (which are, according to our supposition, the primitive seat of metallic elements) it again deposited at a certain level above it, at a definite temperature. The deposition went on, according to circumstances, either more or less energetically, or slowly and periodically, and the deposit was in consequence either massive or stratified. The amount of this deposition must, at any one time, have been unequal at the various levels of the fissures, according to their temperature; and also, in like manner, the variable conductibility, chemical affinity, and dissimilarity of the neighbouring rock must have exercised an influence upon it. But if, on the extinguishing of the plutonic activity of the whole district the mean temperature of each level continued, in consequence of the cooling, to decrease gradually while these processes of dissolving and vein-depositing still continued, it is evident that the zones of unequal deposition must descend deeper, and become mixed together promiscuously. Since we have found that the original inequality of temperature and the variations existing in the neighbouring rocks might give rise to a zone-like distribution of the materials, so the result would necessarily become much more complicated by the alteration of one of these conditions—temperature. The same materials which were deposited at the beginning in the upper levels, next the walls of the fissures, as outer bands, would by the continued cooling be repeated in deeper regions, in the middle of the vein. But the consequences would become yet more complicated, if we must assume that in a vein-district all the fissures were not opened at the same time, but by degrees, at successive periods, and after the process of filling up had already begun; and further, that of those formed at the same time, some became quite filled up before others. As there results from a gradual depression of the temperature of the whole vein-region a kind of series and succession of successively deposited minerals, so it would happen from the different periods of fissure-formation that certain fissures might only contain the earliest mineral-deposits, others only the latest, while some would have a very extended succession. Thus, and no otherwise, can the so-called vein-formations of distinct districts have originated. They are nothing else than the products of unequal stadii of cooling of one and the same eruptive or vein-forming process. The frequent parallelism and grouping together of veins of similar formation is very easily explained by the circumstance that earthquakes generally open more or less parallel fissure-groups. We need only consider such a vein-region as a region in which, in the course of a thousand years, many fissure-opening disturbances have followed upon each other.

If these so-called vein-formations sometimes show great analogies of mineralogical composition and of successive age in very remote regions, we need not after this consider them in any way as contemporaneous—as formations acted upon by processes affecting the whole earth's surface at the same time. If our supposition be correct, they are only the everywhere tolerably analogous consequences of local eruption, which may have been very far separated from each other by time. The baryte-veins at Freiberg, in the Thüringer Wald, and in the south of France, may belong to very different geological epochs; they are to be considered, wherever they are found, as representing the same stadium of local eruptive activity. The same holds good for the regular succession of minerals found in veins, druses, and amygdaloids; the same series may have repeated itself at very different times. The stages of this series cannot, therefore, be used generally to define age like those of the sedimentary formations; they intimate only the *relative* age of the isolated local process of formation.

We shall now endeavour to apply these general theories to the more essential phenomena of the Freiberg ore-veins.

(To be continued).

NOTES AND QUERIES.

FIELD-MEETINGS OF THE GEOLOGISTS' ASSOCIATION.—SIR,—In the last number of your excellent magazine a letter appeared, in which a suggestion was brought forward that it would be well for the Geologists' Association to institute occasional field-meetings. Such a course would be, without doubt, exceedingly advantageous, as it would tend to make the members better acquainted with each other, and to increase their interest in the science. For my own part I should be very glad to see the plan adopted, knowing that a lecture giving at a natural section and on the fossils *in situ* is far more valuable and instructive than one illustrated by the most expensive diagrams. The committee of the Geologists' Association, however, feel they are not in a position to carry out the proposal during the present year; but they hope, and they have deputed me to make this statement, that during the next they shall be able to invite the members to a geological ramble, and to spend a summer's-day both pleasantly and profitably.—I am, Sir, yours faithfully, THOMAS WILTSHIRE.

ARTIFICIAL ORIGIN OF ROCK-BASINS.—In your magazine, valuable on account of the popular style in which it treats our beautiful science, I was last month very pleased to read the remarks of Mr. Rupert Jones on the weathering of granite, and especially that portion of them referring to the rock-basins of Dartmoor. Having been born and brought up in the neighbourhood of this district, I happen to know the rock-basins, logging-stones, and cheese-shaped granite-rocks well; and it is because I am obliged to take exception to the rks of Mr. Rupert Jones on the formation of the "rock-basins," that I am induced to ask you to find room in your next issue for these cursory remarks of mine.

I may perhaps remark first that there is a fine specimen of a logging-stone at Lustleigh, somewhat similar in shape to that of St. Levin's, Cornwall, shown in your engraving last month.

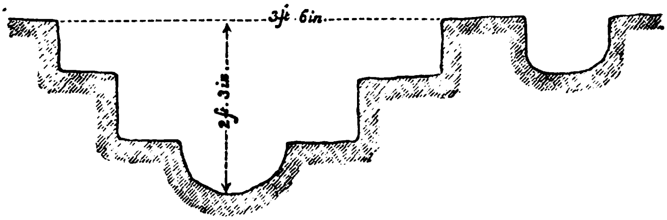
Lustleigh is a small village in the Dartmoor district, about four miles from the Blackistone Rock, also shown in one of your engravings. The wildness and beauty of the neighbourhood of this village will amply repay a visit from any of your readers who may happen to take the West for their holiday-ramble this year. It is about fourteen miles from Exeter. The precipitous hills, perhaps I ought to say mountains, for mountains they are in a geological sense, and the immense granite-rocks, in vast numbers, protruding from the ground give an air of the wildest confusion to the scenery, so that we might easily picture to the mind the tumultuous scene once upon a time enacted there, and which may be yet again.

Being a somewhat of an antiquarian, as well as a geologist, I cannot keep silence when I see the formation of the rock-basins scientifically explained away, yet explained away it is not, for nothing is settled; and the suggestions of both Dr. M'Culloch and Mr. Ormerod seem to me highly improbable, as in a great measure also do the remarks of Mr. Jones.

In all the basins, whether deep or shallow, at times may be found quartz and felspar fragments of an angular shape, and sometimes schorl mixed with it. These materials form a sand of various degrees of coarseness—sometimes fine, sometimes coarse, and are blown into the basins by the wind, but in no case are they formed of the *débris* of the granite-basin in which those materials are found. That many of the basins have been enlarged by the decomposing power of water and the action of the atmosphere cannot, I think, be doubted; but to ascribe the actual formation of all the rock-basins to such a cause is a far-fetched supposition, and totally unwarranted by the facts.

Much of the porphyry of Dartmoor is of a very soft nature, extremely liable to decomposition from the united agency of the atmosphere and water; and the eye can quickly detect the harder and softer rocks. These rock-basins were undoubtedly at one time all circular, and were equally undoubtedly the work of Druidic hands. This is not the place to enter into the mystical symbolical circlic rites of the Druids, suffice it to say, therefore, that the circle was to them a holy thing; that such basins were used by them in their worship; and that they chose earth's wildest scenes as their temples.

About eight or nine years since there was near Blackistone Rock a series of basins cut one into the other, in perhaps one of the hardest and most solid rocks of the whole district (the following sketch is a section); and, moreover, on one of the faces of the rock was carved a representation of a bullock, somewhat worn away it is true by the mouldering work of centuries, yet still beautifully plain. The various basins were, so hard was the rock, almost as



fresh and as smooth as when they were first cut. Unfortunately, this perhaps most splendid Druidical remain in the kingdom, was sold by the farmer, Mr. Amory, on whose estate the rock lay, to a granite-mason of Exeter, who, an old and experienced hand, considered this the hardest and best piece of rock he had ever worked. No sign of apparent stratification, no tabular formation, no flaw, no crack in any part, but one solid, compact mass, without sign of decay anywhere. The plan of all these basins is the circle. Thus has this beautiful remnant of the past been lost to us, and methinks Mr. Jones' remarks in this instance will quite fail in their application. The carving of the bullock and the circles are so decidedly Druidic, and the character of the rock so different from what is laid down in Mr. Jones' remarks, that the contrary conclusion must of necessity be come to, viz., that *this* rock-basin at least was not caused by atmospheric action. There are many others which, though not so elaborate, must yet be put down in the same category. Some of the basins are indeed carved on rounded tors, the sides of which are sloping or smooth, and in which the projecting beds are neither frequent nor bold; such as do project being for the most part rounded at the edges, simply because the carvers looked not so much at the degree of hardness of the rock as to its position for the required purpose: therefore, as might be expected, the atmospheric and aqueous agency of centuries have elongated the circles by the wearing of their sides in the manner described by Mr. Jones. Moreover, these rock-basins are not found in any part of the world where those executors of mystic forms could not reach to work, or where, perhaps, Druidic rites were not known. Surely, if the atmosphere is the cause, these rock-basins might be found in all granite regions, and in all latitudes.

Whilst speaking of rock-basins I may perhaps mention the locality where they may be found in another and very different material. About a mile from the town of Chudleigh, and within nine or ten miles of the district I have been speaking of, is Ugbrooke Park, the seat of Lord Clifford, one of the most beautiful for scenery, both near and distant, in the kingdom. Aqueous agency in the old time did much for this beautiful park, in the conformation of the ground, from many parts of which bold masses of coralline rock, known as Devonshire marble, protrude from the surface. Near what was once a Danish encampment—which has a high mound round it about a mile in extent, and is as near a circle as possible—is a deep rocky gorge about half a mile in length, the walls in many places being quite perpendicular for a depth of perhaps two hundred or three hundred feet, in other places the slope from the top to the bottom is gradual and thickly wooded. Along this are footpaths to the bottom, and to various parts of the rocks. In the hollow lie some of the *débris* of this chasm—some blocks of stone, being cubes probably of twenty feet each way. Amongst these blocks flows a brook of beautiful water, sometimes bounding over them in cascades. We need not search far for the principal cause of the formation of this gorge. It is due to that frisking, sparkling brook (very often a torrent) at the foot. In these rocks are several large caverns where stalagmite and stalactite may be procured in abundance. Beautiful specimens also of magnesian markings on the limestone may at times be had of the quarrymen, but these are very scarce. I have some in my collection. There are several mines, chiefly of lead, in the neighbourhood, between the town of Chudleigh and the village of Christow, where beautiful specimens of minerals may be obtained. Very near also is the Bovey coal-field, a visit to which will repay the amateur geologist. Fossils may be obtained by the diligent searcher in many places around.

But to return to the rock-basins. In the wildest part of the chasm many of them may be found cut in the large blocks of stone. They are uniform in size, quite circular, about six feet in diameter, and four or five feet deep, with flat bottoms, perpendicular sides, and as smooth as glass. Here too their position, regularity, and manner of formation, point them out not as the operations of nature, but as the works of our forefathers, who delighted to worship the "God of the storm, the thunder, and the tempest;" who knew not the God of love, and who chose their temples accordingly.—FRANCIS E. DRAKE, Hill Field House, Leicester.

THE DISCOVERER OF THE OLDHAMIA.—DEAR SIR,—In the last number of your most useful periodical, THE GEOLOGIST, which has reached me here—namely that for May 1859, I find what appears to be an erroneous statement. In a note at page 184 you say, "The Oldhamiæ found in 1847 by Dr. Kinahan in the Cambrian-rocks of Bray Head were the first relics found in the Cambrian-rocks." And again, at page 189, speaking of Bray Head, you remark, "It was there, however, nine years before Mr. Salter's discoveries in Shropshire, that the first relics of a primordial organized life were found by Dr. Kinahan." I see also in another journal, the "Athenæum," of April 23rd, 1859, in a brief notice of my zealous colleague and collector in Ireland, Mr. Flanagan, that he is stated to have been the "discoverer of the Oldhamia."

I think it desirable to place on record the facts of the case, not because I suppose that there is any credit attached to such a discovery, but simply because it is always well to fix accurately the date of such circumstances.

In vol. iii. of the "Journal of the Geological Society of Dublin," pages 57 and 60 you will find a notice of a paper on Bray Head read by me to the Society, in which you will see these fossils noticed. I stated that I had not, up to that time, been successful in finding "organic remains in the slate rocks of Bray Head, with the exception of some small zoophytic markings, which did not appear referable to known genera." This was first laid before the Society on the 8th of May, 1844, and finally read on the 12th June, 1844. The paper was accompanied by a large collection of these zoophytes. This series was subsequently submitted to my dear friend Edward Forbes, who carefully examined them, and on the 15th November, 1848, described their characters to the Geological Society of Dublin, giving to them the generic name of *Oldhamia*, which had been suggested two years before by Sir H. de la Beche.

Mr. Flanagan subsequently, under my own directions—I being at that time in charge of the Geological Survey in Ireland—visited Bray Head, and carefully examined it for fossils. I personally pointed out to him the places where I had found these *Oldhamia*, and to the then known localities Mr. Flanagan added several others; but so far from being the discoverer of these fossils, he was sent there specially by me to collect them.

You will see from the above that the Oldhamiæ were not discovered by Dr. Kinahan in 1847, but were publicly exhibited and referred to in 1844. They were in reality known to me in 1840, and I have sketches of them of that date; but they were not made public till 1844.

To Dr. Kinahan, geologists are indebted for very valuable contributions to our knowledge of these curious remains—additions made since I left Ireland, and I trust he may long continue to investigate the natural history of his native land with equal success.—I am, dear Sir, yours faithfully, THOMAS OLDHAM, Calcutta, 2nd July, 1859.—Mr. Mackie sincerely regrets the inadvertance referred to in Professor Oldham's letter, which he prints in full, believing there are others who have been accidentally misled in like manner with himself, and that it is proper the real discoverer should have his just merit fairly acknowledged.

ANCIENT CANOES.—SIR,—Is there any reason, antiquarian or geological, why some of the rude canoes of very early date which have been found in peat and estuary deposits in this and other countries should not belong to that early age of the primitive men who were possibly associated on our planet with the mammoth, the great herbivora, and the cave-animals? Have any investigations of the deposits in which such relics have been found been made with sufficient care in any instance to determine their proper geological age? I think such cases are well worthy of consideration in reference to the present highly interesting geological topic.—Yours truly, F. S. A., London.

CRETACEOUS ROCKS IN NORFOLK AND SUFFOLK.—SIR,—On what geological formation are the cretaceous rocks in Norfolk and Suffolk superposed.—T. WARD, Ickworth.—For the most part, we believe, on the Kimmeridge Clay.

REVIEWS.

Geological Survey of Canada.—Report of Progress for 1857. Toronto: J. Lovell. 1858.

The report of progress of the geological survey of an important colony like Canada must always be, whatever the merits of the report, a matter of much interest. It is a matter of interest alone to know how much or how little has been accomplished. The report which has recently been forwarded to us is that for the year 1857, presented to the Legislative Assembly on the 31st March, 1858.

One interesting item in it is the survey of the Huronian formation (the equivalent of our "Longmynd" rocks) along the north shore of Georgian Bay, the chief seat of copper-mining in Canada.

The rocks of this region are much distorted and dislocated, and those examined in the district around Lake Echo are altogether of Huronian age, with the exception of the flat parts near the shores of Lake George and the St. Mary river, which are probably unconformable Silurian strata. In order to follow out the structure of these altered and contorted Huronian rocks, a band of associated limestone was selected as the best developed feature, as well for its peculiar mineral character as from the presence above and below it of a very remarkable conglomerate. This band was followed for considerable distances, and is about two hundred feet in thickness. It presents alternate layers of pale blue or whitish limestone and greenish calcareous and siliceous slate, usually in thin strata. About the middle of the mass there is a calcareous breccia, generally in a massive bed, containing angular fragments of greenstone, trap, and dark blue or blackish impalpable grained slate.

The slate-conglomerate, both above and below the limestone, contains numerous rounded pebbles of various kinds, chiefly of syenite, quartz, gneiss, and jasper. The rocks beneath the lower slate-conglomerate are greenish siliceous slate and pale greenish quartzite; these are underlaid by greenstone, and below is a highly altered green chloritic slate, which is exposed in nearly vertical strata, forming high precipices at the extreme head of the lake.

Above the upper slate-conglomerate a thinly laminated dark blue or blackish slate of very fine texture was observed interstratified with thin beds of dark grey quartzite, overlaid by whitish or pale grey quartzite in some parts succeeded by a mass of greenstone, and in others gradually passing upwards into a quartzose conglomerate with blood-red jasper-pebbles.

Great masses of trap appear to be irregularly interposed among the strata, which are also intersected by numerous fine-grained, compact, greenstone dykes.

The order of succession and the thickness of the beds are thus given:—

Green altered slates of a chloritic character	1,000 feet
Greenstone	400 „
Greenish siliceous slates interstratified with pale greenish quartzite	1,200 „
Slate conglomerate	1,000 „
Limestone	250 „
Slate conglomerate	800 „
Dark-blue or blackish fine-grained slates with dark-grey quartzite	500 „
Whitish or whitish-grey quartzite, passing into quartzose conglomerate with blood-red jasper-pebbles	1,000 „
Greenstone	700 „
	6,850 feet.

Mr. Richardson contributes a valuable paper on the peninsula of Gaspé, his investigations having had for their object the ascertaining of the precise boundaries of the Lower and Upper Silurian, and Devonian rocks.

The Gaspé sandstones are of Devonian age, and contain some remarkable fossil plants; they rest on the great limestone of Cape Gaspé (probably Upper Silurian), and this is again placed uncomformably on the edges of sandstones, conglomerate, limestone, and shale of the Middle and Lower Silurian.

Mr. Robert Bell, attached to the exploring party of Mr. Richardson gives a report on the recent shells which he was instructed to collect. At the Brandy Pots, amongst other shells are recorded *Mytilus edulis*, *Mya arenaria*, *Littorina rudis*, *Buccinum undatum*. At other places visited during the expedition were taken *Pecten Islandicus*, *Spirorbis nautiloides* (?), *Solen ensis*, *Purpura lapillus*.

While walking through the woods of Hare Island, Mr. Bell observed numbers of *Helix hortensis* on the trunks of trees and on the leaves of wild grasses. The species, he says, is one well known to have been imported from Europe; and the number of vessels from thence which take advantage of the safe anchorage of that place readily accounts for the presence of those snails.

In speaking of the capeling, which the fisherman there use as bait for cod-fish, Mr. Bell states that the shoals of those fish "are occasionally so dense that the fish on the outside preventing those on the inside from escaping, a fisherman may go in amongst them without a possibility of their getting away, and take them out with a bucket or any other vessel," as Sir William Logan informed him his Indians did in 1845 with a frying-pan, "and in this way obtain bushels of them in a very short time." On such occasions many of them are sometimes thrown on the beach by the waves, and occasionally they appeared to Mr. Bell to leap ashore, dying before they could struggle back. "I observed hundreds of them," he says, "lying dead along the margin of the water, and I can readily believe what I have heard, that in some parts they are occasionally found lying in heaps which would contain several bushels mingled with shells, seaweeds, and the remains of land-plants."

One such heap observed by Sir William Logan measured thirty paces along the margin, while it was a foot deep in the middle and several feet wide, tapering away at each end.

Mr. James Hall adds a valuable paper on Graptolites, to be illustrated by sixteen plates of specimens collected by the officers of the Canadian Survey. Mr. Billings, the palæontologist of the survey, has nearly thirty pages of the report devoted to his descriptions of the fossils obtained during the expedition, and determined by himself during the previous year.

Mr. Sterry Hunt reports the results of his chemical investigations, in connection with the survey, for the previous year. These are chiefly analyses of various dolomites and magnesian limestones, and experiments to serve to explain the conditions and mode of their formation.

The term dolomite is employed to designate a mineral which, in its purest state, is composed of equivalent weights of carbonate of lime and carbonate of magnesia, these being in the proportion of 50 to 42, or in 100 parts of 54·35 carbonate of lime, and 45·65 of carbonate of magnesia. This compound is distinguished from carbonate of lime by its superior density (2·85 to 2·90), by its somewhat superior hardness, and by its being much less readily attacked by acids than carbonate of lime. At ordinary temperatures it does not perceptibly effervesce with nitric or muriatic acids unless reduced to powder. Calcined it is said to yield a stronger mortar than ordinary lime, but slakes slowly and with little evolution of heat.

A portion of the magnesia in dolomite is often replaced by protoxyd of iron, and more rarely by oxyd of manganese; those dolomites containing carbonate of iron being generally yellowish or reddish on their weathered surfaces from a change of a portion of the iron into hydrated peroxyd, and those containing carbonate of manganese become brownish-black on the exterior from a similar cause.

Besides the crystallized dolomites which occur in veins and cavities in various rocks, and have received the names of *bitter-spar* and *pearl-spar* (the latter in allusion to the pearly lustre of the faces of the rhombohedrons which are generally curved), we find this double carbonate forming great beds of a rock which is also known by the name of magnesian limestone. The yellow magnesian limestones of the Permian system in England are those best known, and have in some cases a total thickness of 300 feet. These are immediately overlaid by gypseous marls, to which succeed the limestones, gypsum, and rock-salt of the Triassic series. Similar magnesian limestones occur in the Devonian and Carboniferous formations in England and Russia; and, descending in the geological series, we find in the Saliferous group of Western Canada and New York-beds of dolomite with gypsum. Immediately below, in the Niagara group, there occurs a remarkable deposit of dolomite. Dolomites also occur interstratified with pure limestones in the Hudson River group; while in Michigan, Iowa, and Minnesota, the calcareous strata overlying the Potsdam sandstone, and corresponding to the Calciferous sand-rock, are highly magnesian, often constituting true dolomites.

Thin layers of dolomite are also met with among the limestones of the Chazy division in the island of Montreal. The argillaceous limestone from this formation at Hull (Canada), employed as an hydraulic cement, also contains about 20 per cent. of magnesian carbonate.

Beneath the oldest known fossiliferous rocks of Canada, among the limestones of the Laurentian series, are great beds of dolomite, sometimes ferriferous, and often containing serpentine and other siliceous minerals.

Ascending from the Permian, we find the Jurassic formation of the European Alps containing immense masses of dolomite; and the same occurs in the like deposits of France and Germany.

In Gascony, and in the Paris basin, dolomites occur in the Cretaceous formation; and there is a deposit of dolomite in the Tertiary strata of Pont St. Maxence, in the valley of the Oise, in France. This latter, forming irregular beds or masses several feet in thickness, reposes upon nummulitic limestone, and is overlaid by the *calcaire grossier*. Its condition is that of an incoherent sand, which consists, according to Damour, of nearly pure crystalline dolomite, with a little bitumen and some quartzose sand. Between it and the overlying fossiliferous limestone is a thin layer of yellowish tufaceous cellular limestone, which does not contain a trace of magnesia.

Mr. J. D. Dana has pointed out a dolomite of recent origin in Matea, an elevated coral island, near Tahiti, where, among the limestones which he supposes to have been formed by the solidification of coral-mud, is one containing 8·3 per cent. of magnesia, and another which, according to Prof. Silliman jun., yields 38·07 per cent. of carbonate of magnesia. This dolomite is compact, finely granular, tenaceous, and at the same time cavernous; its density in powder 2·83, its hardness above 4·0. Mr. Hunt's analysis gave 38·25 per cent. of carbonate of magnesia 0·30 silica, 60·50 carbonate of lime.

The preceding dolomites belong to marine formations, but dolomites are also said to occur in the lacustrine limestone at Dächingen, near Ulm, and in the brown-coal formation at Giessen.

From the facts stated, it appears that the production of dolomites has been continued from the times of the earliest stratified rocks to the Tertiary period, and that it is even now going on.

Apart from the altered crystalline dolomites of metamorphic strata, the generally crystalline texture of those of unaltered regions is remarkable. In some cases the rock is an aggregate of pearly, cleavable grains of dolomite, which occasionally have but little coherence, or are in the form of loose sand. At other times the rock is concretionary, having an oolitic or a botryoidal structure, the masses often exhibiting a radiated arrangement; more rarely compact varieties of dolomite are met with. The concretionary action has sometimes so far disturbed the original arrangement as to obliterate the marks of stratification; and most dolomites exhibit cavities which have often been subsequently filled with deposits of other minerals, and seem to indicate a contraction, apparently attendant upon chemical change after the deposition of the rock.

A remarkable mode of occurrence is that in which dolomite forms the cement of breccias and conglomerates. Rocks of this kind occur in the Quebec division of the Hudson River-group, where rounded fragments of limestone, shale, and even of dolomite, have been re-cemented into a rock by the introduction of a crystalline ferriferous dolomite. Analagous to this is the well known conglomerate of the Permian formation near Bristol and in other parts of England, where, in hollows of the mountain-limestone are found accumulations of fragments of this limestone, with others of coal-shale, mixed with the bones and teeth of saurians, the whole cemented together by a red or yellow dolomite, and resting unconformably upon the carboniferous strata. Similar conglomerates occur in the same formation in Normandy, where they inclose concretionary masses of nearly pure dolomite; while in the Permian rocks of the Vosges concretions of sandy dolomite occur, imbedded in layers of micaceous sandy clay, itself sometimes agglutinated by a dolomitic cement.

A crystalline ferriferous dolomite fills the shells of *Orthoceras*, *Pleurotomaria*, and *Murchisonia*, as well as small fissures in the non-magnesian "Trenton" limestones of Ohawa; and similar examples occur in the Chazy-limestones of Montreal. While these dolomitic casts thus occur in pure limestone, on the other hand beds of the Niagara formation, in some places, present purely calcareous corals embedded in a yellow magnesian limestone.

Mr. Hunt then gives us analyses and more minute descriptions of numerous limestones and dolomites from various parts; the separation of the dolomitic portion from the limestone being effected on the principle laid down many years ago by Karsten, who pointed out that acetic acid in the cold scarcely attacks dolomite, although it readily dissolves carbonate of lime; hence, the magnesian limestones, when treated with this acid, leave a residue of dolomite. We have seen that pure dolomites consist of equal equivalents of the two carbonates: there are not wanting, however, rocks in which the magnesian carbonate predominates over the lime, leading to the supposition of a mixture of magnesite with the dolomite. Such examples occur in the Muschelkalk of Thuringia; in the bituminous magnesian rock of the Salzberger Alps; in the brown-coal deposits of Giessen; in the Calciferous sand-rock of Lake Superior; in the variegated marls of the Keuper of Germany; and in a dark-grey rock of the same formation at Tubingen, and at Solothurn, in the analysis of some of which we perceive the transition from dolomites to a ferriferous magnesite.

The question of the origin and formation of dolomites and magnesian limestones has long been regarded as one of extreme difficulty, and among the many solutions hitherto proposed, none appear to be satisfactory. We will, however, review them briefly.

It is a well known fact that carbonate of magnesia occurs in but very small quantities in calcareous tufas and travertine. The same thing is true in the case of limestones of organic origin, which are generally pure carbonate of lime. Such limestones are made up for the greater part of the remains, often finely comminuted, of corals and molluscs; the living species of these are in general nearly pure carbonate of lime, and recent corals usually contain less than one per cent. of magnesian carbonate. Millepores are in like manner in the greater proportion, constituted of carbonate of lime; in some, however, the carbonate of magnesia attains from 16·0 to 19·0 per cent. of the inorganic portion. These millepores are often very abundant, and a non-magnesian species forms beds on the northern shores of France that are worked for burning into lime; while a species, containing a large proportion of magnesia is very abundant on the coast of Algiers. M. Damour has called attention to the part these mellipores may play in the production of magnesian limestones in the "Annales de Chimie et de Physique" (3rd series, vol. xxxii., p. 362). He, however, describes them as dissolving readily in acetic acid, and which would seem to indicate the absence of dolomite.

The carbonates of lime and magnesia are both much more soluble in carbonated water than the double carbonate, which, according to Bischoff, yields little or no magnesia to a solution of carbonic acid. Grandjean and, after him, Sandberger, supposes that certain dolomites may have been formed from limestones containing an admixture of carbonate of magnesia by the action of carbonated waters, which might give rise to dolomite and a soluble bi-carbonate of lime; the iron and other metallic oxyd, being thus concentrated in the residue, their presence in some dolomites would be explained (Liebig and Kopp, "Jahresberischt," 1848, English edition, vol. ii., p. 501).

Forchammer, in attempting to illustrate by experiment the formation of dolomite, found that when a solution of bicarbonate of lime is mingled with sea-water at a boiling heat, the precipitated carbonate of lime carried down with it 12·33 per cent. of carbonate of magnesia; while, if carbonate of soda be mixed with the solution of bi-carbonate, the proportion of magnesian carbonate in the precipitate may rise to 27·93 per cent. The amount of magnesia according to his statements appearing to augment in proportion with the increase of temperature.

Haidinger long since endeavoured to explain the formation of dolomite and its frequent association with gypsum, by supposing that a re-action between carbonate of lime and sulphate of magnesia might give rise to sulphate of lime and carbonate of magnesia. At ordinary temperatures, however, the inverse affinities prevail. Mitscherlich found that a solution of gypsum was completely decomposed after fourteen days contact with carbonate of magnesia into sulphate of magnesia and carbonate of lime; and the same decomposition takes place when a solution of gypsum is filtered through dolomite. Haidinger, however, conjectured that at an elevated temperature these affinities might be reversed, and this has been confirmed by Morlot, who found that when a mixture of one equivalent of crystallized sulphate of magnesia, and two equivalents of calcareous spar is heated in sealed tubes to 200 degrees centigrade, it is completely converted into dolomite and sulphate of lime.

Marignac, in like manner, found that at 200 degrees centigrade, carbonate of lime, with a solution of chlorid of magnesium, slowly gave rise to a double carbonate of lime and magnesia; after six hours the product contained 52·0 per cent. of carbonate of magnesia (Favre. Bull. Soc. Geol. France, vol. vi., p. 318).

De Sénarmont found in some experiments with mingled solutions of bicarbonate of magnesia and chlorid of calcium, that at the ordinary temperature, and at temperatures below 100 degrees centigrade, a precipitate of pure carbonate of lime separates, provided that the proportion of chlorid of calcium present is more than equivalent to the magnesia in solution; but at 150 degrees, whether the lime-salt be in excess or not, a precipitate of carbonate of magnesia is obtained with little or no lime.

Taking the experiments of Morlot and the theory of Haidinger as a point of departure, Favre attempts to explain the formation of dolomites. He supposes that eruptions of igneous rocks at the bottom of a sea 500 or 600 feet in depth would afford the necessary conditions of heat and pressure; and since the dolomites of the Alps are associated with melaphyres, which are more or less magnesian, he supposes a simultaneous evolution of sulphurous and hydrochloric acids; these acting upon the ejected rocks, would produce the magnesian salts necessary for the conversion into dolomites of the adjacent limestones, which, according to him, are interstratified near their base with pyroxenic tufa. These dolomites of the Tyrol are filled with small cavities, while they retain the marks of stratification, and exhibit the remains of corals and encrinites. Favre supposes they were originally deposited as pure limestones, and became cavernous in their subsequent conversion into dolomite; and he conceives that the sea, beneath which the volcanic eruptions took place, was widely extended, and thus explains the formation of dolomites far away from any intrusive rocks; at the same time he admits that compact dolomites in many stratified rocks have been originally deposited as such, and are not the result of alteration.

The famous theory of Von Buch, based in great part upon these dolomites of the Tyrol, supposes that the dolomitization of limestones has been effected by the intervention of some volatile compound of magnesia evolved during the eruption of the porphyries of that region. In support of this hypothesis Durocher made the experiment of heating together to low redness, in an iron tube, fragments of porous limestone and anhydrous chlorid of magnesium for some hours. The soluble matter being then washed away, the residue effervesced strongly at first with hydrochloric acid; but the action then became feebler, and the residue exhibited transparent crystals under the microscope, which were supposed to be dolomite, but were not further examined (Philosophical Magazine, vol. ii., p. 504).

To Von Buch's theory it must be objected that no known compound of magnesium is volatile; and that it is only by the intervention of water that we can at all connect the dolomitization of limestones with the eruption of igneous rocks. Fournet, too, has since shown that the melaphyres associated with the dolomites of the Tyrol, so far from being intrusive, are themselves stratified rocks, probably of the carboniferous age, metamorphosed *in situ*, and that their alteration was effected long before the deposition of the dolomites, which are of the Jurassic period; for between those metamorphic strata and the dolomites are beds of unaltered Triassic rocks, including the Muschelkalk and a conglomerate which contains rolled pebbles of the subjacent melaphyres (Bull. Soc. Geol. de France, vol. vi., p. 506).

Delesse has remarked that in many instances limestones which have been regarded as dolomitized by the proximity of igneous rocks, have been rendered crystalline, but contain no magnesia. Delanoüe has pointed out examples of a similar error in the crystalline limestones of the calamine mines in Belgium, where in cases of supposed dolomitization by contact with igneous rocks, he found no increase in the proportion of magnesia.

These facts show that dolomities have been formed under conditions where the theory of the intervention of volcanic and metamorphic agencies is inadmissible, and we are to conclude that they have been deposited as magnesian sediments in seas, or sometimes in lacustrine basins, from waters which often permitted the development of animal life. The conditions required for the separation of carbonate of magnesia from the sea or other waters, therefore, naturally claim our attention as a first step towards the solution of the problem before us. Mr. Hunt has already shown in a previous report, that the precipitate produced by carbonate of soda in water containing soluble salts of lime and magnesia consists in great part of carbonate of lime, the magnesium salts being decomposed only after the lime has been removed; and some experiments since made with carbonated waters serve further to illustrate this geologically important fact.

If to an artificial sea-water, containing, besides common salt, chlorids of calcium and magnesium in the proportion of one equivalent of each, we add a solution of bi-carbonate of soda in water saturated with carbonic acid, a gelatinous precipitate separates, which immediately becomes crystalline. This precipitate being separated after a few hours, and submitted to analysis, gave three successive precipitations from the same liquid of 2·20, 2·00, and 1·23 per cent. of carbonate of magnesia, the remainder being carbonate of lime; the proportion of magnesia thus diminishing as the magnesian salt became predominant in the solution, which now gave no further precipitate with bi-carbonate of soda, but deposited by evaporation to dryness, a granular residue of hydrated carbonate of magnesia with a little carbonate of lime.

Bineau has shown that if we evaporate solutions containing bi-carbonates of lime and magnesia in presence of sulphate or muriate of lime either at the ordinary temperature or by artificial heat, the carbonate of lime is deposited with but a trace of magnesia. From this he concludes that the carbonates of magnesia exhibit, with all the soluble salts of lime, the same reactions of incompatibility as the corresponding carbonate of potash and soda (Ann. de Chim. et de Phys., vol. li., p. 302).

Another cause which prevents the precipitation of carbonate of magnesia with the carbonate of lime, even when other salts of lime no longer exist in the solution, is found in the great solubility of bi-carbonate of magnesia as compared with the bi-carbonate of lime. According to Bischoff, carbonate of lime requiries for its solution about 1,000 parts of water saturated with carbonic acid; and Mr. Hunt states that he has found it quite easy to obtain solutions containing 10·0 grams of magnesia, equal to 21·0 grams of carbonate of magnesia to a litre of water, or 2·1 per cent. Bineau found that by the aid of a current of carbonic acid prolonged for several days, a solution might be obtained containing 11·2 grains of magnesia, combined with nearly two equivalents of carbonic acid, in a litre of water. Such solution by spontaneous evaporation in the open air loses carbonic acid and deposits carbonate of magnesia, finally retaining only 0·108 grains of magnesia in a litre, with carbonic acid sufficient to form a sesqui-carbonate.

When recently precipitated hydrated carbonate of magnesia is added to a solution of bi-carbonate of lime, it immediately dissolves, but the transparent solution soon after becomes troubled from the precipitation of carbonate of lime. This reaction is precisely analogous to that produced by carbonate of soda, which, with bi-carbonate of lime, gives a precipitate of neutral carbonate. The results of a variety of experiments, undertaken in the hope of producing a double carbonate of lime and magnesia, have shown that when the bi-carbonates of lime and magnesia are dissolved in pure water, in solutions of sea-salt, of chlorid of magnesium, or of carbonate of soda, and evaporated at the ordinary temperature, or heated to 100 degrees Fahrenheit, the carbonate of lime is deposited as in the previous experiments, carrying with it only traces of the magnesian carbonate, which is afterwards separated by elevating the temperature nearly to boiling point or by farther evaporation.

The addition of chlorid of calcium suffices, even at ordinary temperatures to decompose the magnesian bi-carbonate and to precipitate carbonate of lime; but when the solution of the two bi-carbonates is boiled, even in the presence of chlorid of calcium, a portion of the magnesia falls down with the carbonate of lime. In none of these conditions, however, do we obtain that double carbonate of lime and magnesia, insoluble in acetic acid, which forms the base of the magnesian limestones; nor have we in them any evidence of the formation of a true dolomite.

Mr. Hunt has found in the course of his experiments that the introduction of a soluble sulphate modifies, in an unsuspected manner, the results already described. Mitscherlich found gypsum to be incompatible at ordinary temperatures with carbonate of magnesia, but it is no longer so in the presence of an excess of carbonic acid; in fact, gypsum may be crystallized from a solution of bi-carbonate of magnesia.

If to a solution of bi-carbonate of lime, sulphate of magnesia is added, and the liquid allowed to evaporate at any ordinary temperature to a small volume, the whole of the lime is deposited in the form of crystalline gypsum. The same result is obtained when bi-carbonate of lime is added to a solution containing sea-salt, chlorid of magnesium, and sulphates. By evaporation at a temperature of from 90 to 100 degrees Fahrenheit the gypsum is entirely deposited before the separation of the sea-salt commences, while the bi-carbonate of magnesia remains in solution, and is only separated by evaporation to complete dryness, or by ebullition. This reaction may help to explain the frequent association of gypsum and dolomite, as well as in the occurrence of both in fresh-water formations; but "it is evident," Mr. Hunt says in conclusion, "that with the facts as yet before us we are not able to determine with certainty the manner in which dolomites have been formed.

"Bi-carbonate of magnesia may, however, be produced in two ways:—first, by the action of bi-carbonate of lime upon waters containing both sulphates and magnesian salts, gypsum being generated at the same time; and secondly, by the action of bi-carbonate of soda upon magnesian waters from which the lime has previously been separated either as a carbonate by the previous action of bi-carbonate of soda, or by evaporation in the form of sulphate, as takes place during the concentration of sea-water. From these solutions beds of carbonate of magnesia may readily be formed by evaporation in limited basins, precisely as we conceive gypsum and rock-salt to have been deposited; and if we suppose an admixture of carbonate of lime deposited from alkaline waters or any other source, we have all the elements of dolomite, although not chemically combined as a double salt. M. St. Claire Deville in his beautiful researches on the double carbonates, found that when a mixture of basic carbonate of magnesia with bi-carbonate of soda and water is exposed to a gentle heat, a slow combination ensues, and the mixture is transformed into a mass of small transparent crystals, which are an anhydrous double carbonate of soda and magnesia, insoluble in water—in fact a soda-dolomite (Ann. de Chim. et Phys., vol. xxxiii., p. 89).

"A similar reaction between the mingled carbonates of lime and magnesia, under conditions not yet understood, may probably result in their gradual transformation into dolomite."

Although we have given Mr. Hunt's paper only in a slightly condensed form and almost in his own words, the portions we have omitted are not by any means valueless, but should be read by those who are specially interested in this curious subject. We have abstracted sufficient to give the general reader a clear notion of the state of investigation up to this point.

In the "Canadian Journal" for May, 1859, Mr. Hunt has published some additional remarks upon this interesting subject in confirmation of his view "that dolomites have been formed in sea-basins, from which the soluble salts of lime have been completely separated, as sulphate or as carbonate by the agency of alkaline carbonates, which afterwards gave rise to carbonate of magnesia," which carbonate "appears capable, under certain conditions, of slowly combining with carbonate of lime, and forming with it a double carbonate, which is dolomite."

Referring to the Report under review, he says, "I have (there) shown two processes by which sediments of magnesian carbonate may be formed. First, by the action of solutions of bi-carbonate of soda on basins of sea-water, which precipitate all the lime as carbonate, and then give rise to a soluble bi-carbonate of magnesia; and secondly, the action of bi-carbonate of lime on solutions containing sulphate of magnesia. I have found that the presence of this salt greatly increases the solubility of bi-carbonate of lime in water—bi-carbonate of magnesia and sulphate of lime being formed by double decomposition. By adding alcohol to such a solution, or by evaporating it at a gentle heat, gypsum is deposited, leaving the more soluble bi-carbonate of magnesia in solution.

"In the same way, alcohol separates gypsum from a mixed solution of bicarbonate of lime and sulphate of soda—an alkaline bi-carbonate remaining dissolved.

"The subsequent evaporation in shallow lakes, or basins, of solutions of bicarbonate of magnesia, formed by either of the above-mentioned processes, must give rise to deposits of hydrated carbonate of magnesia more frequently mingled with carbonate of lime, supplied by springs containing either bicarbonate of lime or chloride of calcium. The hydrated carbonate of magnesia, at 160 degrees C., and perhaps at a lower temperature, under pressure to prevent the loss of carbonic acid, is converted into magnesite or anhydrous carbonate of magnesia; but if carbonate of lime be present, the two combine to form a double carbonate, which is dolomite, and may be separated from intermixed carbonate of lime by the action of dilute acetic acid, at 32 degrees F., which readily dissolves the latter, but attacks the dolomite more slowly.

"I have found this union of the two carbonates to take place alike in the presence of earthy and alkaline chlorides, sulphates, and carbonates, at temperatures between 130 and 200 degrees centigrade. A portion of the magnesia is always, under these conditions, converted into magnesite, and may be partially separated from the dolomite, by taking advantage of the fact that it is less soluble in acetic acid at the temperature of 60 degrees F. than the double carbonate. In nature, the combination must take place at the lowest possible temperature, and one which is probably insufficient to produce the insoluble magnesite. This, when once found, I have shown to have no tendency to unite with carbonate of lime.

"The application of these observations to the various conditions in which dolomites and magnesites are met with in nature, and especially to their association with gypsum and anhydrite, is evident."

Some further interesting remarks are added by Mr. Hunt, in his report, upon Fish-manures; and the volume is concluded by a paper by Lieut. E. D. Ashe on the longitude of some of the principal places in Canada, as determined by electric telegraph in the years 1856-7.

THE GEOLOGIST.

OCTOBER, 1859.

THE COMMON FOSSILS OF THE BRITISH ROCKS.

By S. J. Mackie, F.G.S., F.S.A.

(Continued from page 355.)

Chap. 5.—*First Traces of the Succession of Life.—The Lower Silurian Rocks.*

For the Vegetable Kingdom it is impossible to give any list composed with the same degree of elaboration as has been attained in the classification of animals. Modern plants are, it is true, as well known and as correctly grouped as modern animal life-forms; but our knowledge of fossil botany is not at all equal to our knowledge of fossil animals. The most minute divisions as well as the most important of botanical classifications are dependent upon the more fully developed and most perishable parts of vegetable organisms—the flowers and the fruits or seeds. Of these the former, the most essential of all, have rarely indeed, if ever, been preserved. One or two doubtful instances have been stated; but these have been by others disputed as being only incipient buds or leaflets, or as accidental appearances, and the investigator of the extinct forms of the vegetable creations of past geological ages has, at the best, to infer from the remains of leaves, branches, or stems, usually more or less decayed, the probable class to which the originals—often, indeed generally, of very different structures and organic characters from his existing types—belong. Not uncommonly, indeed, his only guides are vague and indefinite resemblances of form. Still, however, if it be essential for the attainment of a knowledge of the exact concatenation of past events in the succession of organic life on our planet, it is equally as important to note whether plants have been progressive in their development, as to determine this point in relation to the animal-kingdom. Rudimentary vegetables, like rudimentary animals, are simple cells; and at a glance everyone would perceive the beautiful flowers in our gardens and greeneries to be far more highly organized than the toad-stool sprouting around the mouldering fence, or the leathery lichen clinging to the crumbling wall. The same questions, too, will naturally be asked, "Were the simplest plants created first?" and "What was the first vegetation that appeared on our earth?"

Here, then, we have need of a connected list of the vegetable world, both in its present and past conditions, if we would rightly comprehend even those facts which geologists have been able so far to lay before us. Such a list, however, as one would desire is impracticable in the present state of knowledge, and we therefore content ourselves with presenting one having a sufficiently modified aspect as to serve a useful purpose in our considerations of fossil plants.

All plants are either simple cells, like the yeast-plant, or CELLULAR, that is, structurally composed of a simple aggregation of cells into a *cellular tissue*, such as the green scum-like Confervæ of our ponds, the incrusting lichens on our trees and walls, the Fungi, or mushroom- and mildew-tribes, and the Algæ, most familiarly known by the common seaweeds of our shores. Or they are VASCULAR, *i.e.*, composed of a tissue containing numerous vessels for the circulation of air, the conveyance of nutritive fluids and other purposes. These latter or vascular plants are again subdivided into CRYPTOGAMS, or those having no visible seed-organs, and PHANEROGAMS, or those in which the flowers and seed-vessels are evident.

To the Cryptogams belong the mosses, equiseta (mare's-tails), ferns, and lycopodia or club-mosses; and under the three great divisions of the Phanerogams are ranged the flowering-plants and trees. These divisions are constituted for the sub-grouping of (1st) Those flowering-plants that have but one seed-lobe or *cotyledon*, such as lilies, rushes, grasses, and palms, and which, from their growth by increase from within are denominated *Endogens*. 2nd, For those with naked or unprotected seeds, such as the pine-apple and fir: these, in allusion to this peculiarity, are called *Gymnosperms*. 3rd, For such as have two seed-lobes or cotyledons, as all forest-trees and shrubs, which also are characterized by the possession of true woody structure, the mode of growth being by concentric external layers around the stem, hence the term by which they are denominated—*Exogens.*

The vegetable kingdom is, however, very variously grouped on different and excellent principles by various authors; but the grouping presented in the table below (Table III.) will be found sufficient for, and, we think, best adapted to, geological purposes.

In our considerations of the lowermost of all fossiliferous rocks we have brought under notice the first, or, at any rate, the oldest and most remote forms of created beings as yet brought to light by the researches of geologists. These, if we compare them with the positions of the classes to which they belong in the tables of the animal and vegetable kingdoms, will be found to be not of the lowest grades. The Oldhamia, whatever it may really be, is certainly above the monad or the diatom, and some naturalists have put it even as high as the Sertularidæ; the worm-holes indicate the existence of a more elevated class, the Annelida; while fragments of trilobites carry us still higher in the articulate group. Neither are the obscure vegetable traces with which we are first presented at the bottom of their kingdom, but they rank at least as high as the cellular algæ.

No foraminifers nor sponges, no animals of the globular type, present their remains; no traces of diatoms, lichens, or fungi appear. It may be said these were too perishable in their nature to be preserved. True some might have been so; but others were not, for in rocks less remote in age, diatoms, sponges, and foraminifers abound.

When in Shropshire we pass away from the Longmynds and reach the well-known Stiper-stones; or when in Wales, as at Harlech, we pass from the Cambrian grits to the "Lingula-flags," fossils become more abundant and more diversified. We have then entered into another phase of the great Palæozoic age, and new life-forms appear. One of these, a brachiopod (*Lingula Davisii*) takes rank still higher in the scale of life than any of the few forms met with in the "Bottom-rocks" and presents us with the first appearance of the molluscan type; while it occurs in such abundance, and within such a zone-like special range as to give a characteristic name to the rock-mass in which it is embedded.

TABLE III.—GENERAL GROUPING OF THE VEGETABLE KINGDOM.

SUB-KINGDOM.—PHANEROGAMS *(Flowering-plants).*

Class I. EXOGENS (Outer-growth).

Sub-group.	*Order.*	*Family.*	*Type-form.*
ANGIOSPERMS [*With seed-vessels*].	THALAMIFLORÆ *(Flowers with stamens on the receptacle)*	... ...	Poppy, Geranium
	CALYCIFLORÆ *(Flowers with stamens on the calyx)*	... ...	Rose, Pea
	COROLLIFLORÆ *(Flowers with stamens on the petals)*	... ...	Primrose, Heath
	APETALÆ *(Without petals)*		
	I. ANGIOSPERMOUS	... ...	Spurge, Nettle, Oak, Elm
GYMNOSPERMS [*Naked seeds*].	II. GYMNOSPERMOUS	... ...	Pine, Cypress, Cycas

Class II. ENDOGENS (Inward-growth).

Sub-group.	*Order.*	*Family.*	*Type-form.*
	DICTYOGENÆ *(Net-growing=reticulated leaves)*	... ...	Yam, Sarsaparilla
	PETALOIDEÆ *(Generally with petals)*	*Alismaceæ* (Alisma-tribe)	Water-plantain
		Liliaceæ (Lily-tribe)	Lily
		Juncaceæ (Rush-tribe)	Rush
		Orchidaceæ (Orchis-tribe)	Orchis
		Marantaceæ (Arrow-root-tribe)	Arrowroot
		Zingiberaceæ (Ginger-tribe)	Ginger
		Musaceæ (Musa-tribe)	Banana
		Iridaceæ (Iris-tribe)	Flag
		Narcissaceæ (Narcissus-tribe)	Daffodil
		Bromeliaceæ (Bromelia-tribe)	Pineapple
		Naiadaceæ (Naiad-tribe)	Pond-weed
		Palmaceæ (Palm-tribe)	
		Lepidocaryaceæ	Reed-palm, Sago palm
		Borassaceæ	Fan-palm

		Aracaceæ	Cabbage-palm
		Cocaceæ	Cocoa-nut-palm
		Pandanaceæ (Pandanus-tribe)	Screw-pine
	GLUMIFERÆ *(Scale-flowered)*	*Cyperaceæ* (Sedge-tribe)	Sedge
		Graminaceæ (Grass-tribe)	Grass

SUB-KINGDOM.—CRYPTOGAMS *(Flowerless-plants)*

Class III. ACROGENS (Growth from extremity).

ANGIOSPORES [*Spores in vessels*].	FILICES *(Fern-tribe)*	*Danæaceæ* (Danæa-tribe)	Tree-fern
		Polypodiaceæ (Polybody-tribe)	Polybody
		Ophioglossaceæ (Adder's Tongue-tribe)	Adder's-tongue
	EQUISITACEÆ *(Equisetum-tribe)*	…	Mare-tail
	MARSILEACEÆ *(Marsilea-tribe)*	…	Pepperwort
	LYCOPODIACEÆ *(Lycopodium-tribe)*	…	Club-moss
	MUSCALES *(Operculate mosses)*	…	Moss
	HEPATICÆ *(Inoperculate mosses)*	…	Liverwort

Class IV. THALLOGENS (Thallus-growth).

GYMNOSPORES [*Naked spores*].	CHARACEÆ *(Chara-tribe)*	…	Chara
	LICHENALES *(Lichen-tribe)*	…	Lichen
	FUNGIALES *(Fungus-tribe)*	…	Mushroom, Mildew
	ALGALES *(Seaweed-tribe)*	*Ceramiaceæ* (Ceramium-tribe)	Rose-tangle
		Fucaceæ (Fucus-tribe)	Sea-wrack
		Confervaceæ (Joint-weeds)	Conferva
		Desmidiaceæ (Desmidium-tribe)	Brittlewort
		Diatomaceæ (Diatom-tribe)	Navicula

Two very important theories have been broached, as it is well known, in regard to the development and succession of organic life upon our planet; the one known as the "progressive development theory," deriving each succeeding higher form by transmutation out of or development from a lower one; the other regarding each new successive form, whatever its organic rank, as a special act of creative energy. It may be very truly said, when we consider the comparative values of these two great doctrines, that we have not yet all the evidence necessary to decide upon their respective merits; and, although in regard to the former, there is a natural tendency of the mind to dissent from the idea of the possession by any organic being of the capability of self-development into a higher form, there are so many resemblances, at least, of a series of like and further-carried developments in the higher classes of plants and animals as to make us hesitate to reject as absurd or valueless doctrines which carry so many specious reasons for their consideration. No doubt the ever and anon exerted power of creation, the placing at intervals throughout all the vast ages of the Past, of new and suitable forms of organisms upon our planet, in accordance with the requirements of its changed and altered conditions, is the more popular view, as it accords more with our preconceived notions of the unceasing watchfulness of the great Creator.

Perhaps the truth may be found to be a modification of both, a certain amount of progressive development being possible within restricted limits, while creative energy from time to time supplies vacuities and deficiencies and the higher grades required by the more elaborated conditions of our globe.

Be all this as it may, our duty is plainly to present facts as we find them, and rather to define what *is truly known* than to enter the domains of speculation. One important fact is even now evident—that while apparently in neither vegetable nor animal kingdom do we start with the lowest group—while seemingly we begin neither with the protozoan nor the diatom—yet every successive great geological age has presented us with some marked successive development of, or the production of some more highly organized condition of animal- or vegetable-life. In the Lower Silurian strata molluscs, annelides, and crustaceans (trilobites and bivalved entomostraca) abound; fish next appear in number; then reptiles reign; then dawns the era of the gigantic mammals; and then the Age of Man sets in. So in vegetation, as far as we can judge from the strange and singular fossil-forms presented to our view, the flowerless preceded the flowering plants and trees which so luxuriantly covered the Tertiary lands, and still adorn our own.

But this remarkable advance, so evident when we regard the grander groups and the results of ages as a whole, becomes less apparent and indeed very obscure when we attempt to combine the seeming links of minor details and to trace one form developing itself into another. We see the age of reptiles succeed that of fish; the age of man following on that of the lower mammals; and we have no difficulty in appreciating the higher stages of each, and the successively improved conditions of our planet to which they were adapted; but when we attempt to trace out links to join the reptile with the fish, and the quadruped mammal with the man, we fail. We may see resemblances of development on either hand, but no true junction-forms; and then again when, as between genera and families, we do meet with connecting species, such may occur in time either in advance or in arrear of the age or ages in which the forms so connected existed; while, on the other hand, some genera, such for example as the Lingula we meet with for the first time in the Lower Silurian rocks, have lasted from their first appearance to the present hour with scarcely more than a specific difference between those primitive individuals and those now living in our seas. One thing, however, seems certain of the Lower Silurian mollusca, crustacea, and annelides, that their geographical distribution was far greater and much more universal than is the case with existing species; and although lines of demarcation have been attempted to be drawn between many of the American Lower Silurian fossils and those of our own country, it is very questionable, at least in some cases, if any real specific distinctions exist.

The general appearance and character of the Stiper-stones have been well described by Sir Roderick Murchison, in whose wake, so great has been his own energy and so powerful the means at his disposal, a British author writing on Silurian strata, is almost compelled to follow. "Trending in a broken mural line from north-

north-east to south-south-west, these stony masses appear to the artist like insulated Cyclopean ruins jutting out upon a lofty moorland ridge, at heights varying from fifteen hundred to sixteen hundred feet above the sea. On reaching the summit of this barren height, the traveller sees below him, to the west, a rapid slope, and beyond it a picturesque hilly tract, the strata of which are laden with Lower Silurian fossils, and diversified by a variety of rocks of igneous origin. In short he has then within his view the original type of formations which, raised to greater altitudes, and effected by a slaty cleavage, occupy large mountainous tracts in Wales."

In the outstanding bosses of the siliceous sandstone of the Stiper-stones, fragments of Lingulæ have been met with, which, as well as their relative position with respect to the underlying and the superimposed beds, identify these strata with the true Lingula-flags of North Wales.

In the Stiper-stone rocks Mr. Salter has also found annelide-tubes, resembling, if not indeed identical with, *Scolithus linearis*, described by Prof. J. Hall, from the Potsdam sandstone; and with waving undulations and ripple-marks in the flag-like beds ramose and twisted forms are found, amongst which casts of a so-called seaweed, the Cruziana or Bilobites, are said to occur. The scolithi are better known in the North American rocks than in our own; we have therefore chosen our figure from a foreign specimen.

Lign. 5.—Scolithus linearis.
[From an American specimen].

The broken and contorted condition of the Lingula met with in the Stiper-stone strata renders it difficult to determine the species; but there appears reason to doubt its being the *Lingula Davisii* of the Welsh strata, with which, however, it is well known some other forms, as yet undescribed, occur; and with some of these it may be hereafter identified.

GENERAL CONSIDERATIONS ON THE FORMATION OF ORE-VEINS.

(*Translated from the German of* PROFESSOR BERNHARD COTTA, of Freiberg, *with an Introductory Notice on the Study of Mineral Veins and Metalliferous Deposits, by* H. C. SALMON, ESQ., Plymouth.)

(*Continued from page* 368).

These veins penetrate the crystalline schists, particularly the gneiss, in those localities where the latter are largely penetrated by porphyry. They also generally penetrate the porphyry; only a few exceptions from this rule serving to show that the porphyry-eruptions continued into the period of the formation of the ore-veins. These veins form three or four principal groups, according to their direction,* which groups in general differ both in age and in contents. Still, all veins by no means show similar directions in connection with similar contents, or the converse, only these predominant characteristics often coincide. Veins of distinctive contents are almost as much confined to certain localities as they are characteristic of definite directions. According to the contents we can distinguish three or four paragenetic combinations of different ages, but which often extend into one another in such a manner that one fissure sometimes contains the products of two or three of these different periods. These paragenetic combinations of vein-contents are:

1. Principally quartz and hornstone, with frequent fragments of the neighbouring rock. There are also found, partly interwoven with the quartz, and partly in numerous drusy cavities, Brown-spar, Manganese-spar, Calc-spar, Strontian, Fluor-spar, Rothgiltigerz, Weisserz, Glaserz, native Silver, common Arsenical pyrites, Argentiferous pyrites, Blende, Weissgiltigerfedererz, Iron-pyrites, &c.† This so-called "great Quartz-formation" predominates in the fissures in the neighbourhood of Bräunsdorf and Siebenlehn. We find about one hundred and fifty veins belonging to this combination.

---

* Compare V. Beust's Gangkarte.

† I have not considered it advisable to give the strict mineralogical names to the mineral-species enumerated. The characteristic German ores I have given in the original names.

2. Quartz, Hornstone, Brown-spar, Calc-spar, and Spathic-iron are combined with Argentiferous galena, Blende, Arsenical pyrites, Argentiferous pyrites, and Copper-pyrites in moderate quantities. More rarely, and particularly in druses, there are found Chlorite, Baryte, Fluor-spar, Fahlerz, Rothgiltigerz, &c.: red-iron is found as a so-called "eiserner Hut" or "gozzan" to the foregoing. This combination has been named the "Lead-pyrites formation," and predominates east and south of Freiberg. About three hundred veins have been found belonging to it, and their direction is mostly forty-five degrees east of north. This combination is intimately connected with the following—

3. Brown-spar, Manganese-spar, and Quartz, with Calc-spar, Baryte, Spathic-iron, Argentiferous galena, Argentiferous blende, Argentiferous pyrites, Arsenical pyrites, Rothgiltigerz, native Silver, Federerz, &c., often forming symmetrical layers in definite succession. Red Iron occurs as a gozzan. Over three hundred veins, mostly bearing forty-five degrees east of north, or north and south, belong to this "great Lead-formation," which, like the foregoing, is more particularly developed east and south of Freiberg.

4. Baryte and Fluor-spar predominate, and alternate with Galena in many thin and regular layers. With these are associated, particularly in the druses in the middle of the vein, Quartz, Spathic-iron, Calc-spar, Brown-spar, Iron-pyrites, brown Blende, richly Argentiferous fahlerz, Copper-pyrites, Rothgiltigerz, native Arsenic, Rauschgelb, Grauspiessglaserz, native Silver, Glaserz, &c. The veins of this "Barytes-lead formation," which mostly bear forty-five degrees east of south, predominate in the neighbourhood of Halsbrücke. We have counted about one hundred and thirty.

These four combinations or formations may, perhaps, in consideration of the great similarity of the 2nd and 3rd, be reduced to three, of which the most general characteristics are as follows:—

I. Quartz and Hornstone, with many fragments of neighbouring rock and with noble ores, particularly in druses. It predominates north and west of Freiberg.

II. Quartz and Carbonates with Sulphides of metals, partly massive, partly disposed in layers. Predominates east of Freiberg.

III. Baryte and Fluor-spar with Galena, and some other ores, disposed in very regular layers. Predominates north of Freiberg.

The order in which these combinations are given is also, at the same time, that of their relative age, and from this we can easily understand how the oldest combination is characterized by quartz and fragments of the neighbouring rocks, while the newest is marked by a particularly regular layer-like form.

According to our theory, the Freiberger ore-veins are due to the porphyry-eruptions. The eruptive force opened fissures from time to time, during a long period; and through these fissures water, perhaps sea-water, penetrating to a great depth, found in the still-heated deeply-lying porphyry-masses (which at Freiberg only penetrate to the surface in isolated dykes) those earths and metals which are soluble under a high pressure at a high temperature and with the co-operation of alcalies; and which it (the water) then subsequently deposited in its circulation through the upper and colder regions of the fissures. Of the earths, silicic acid, when dissolved in great quantities, crystallized again at a very high temperature. For this reason, it fills principally the oldest fissures, or forms the oldest portions in newer ones, or in those which, occupying a medium position in the whole vein-region, preserved longest a very high temperature. The other minerals followed it more or less periodically, according to their capacities for reduction or solidification, which certainly cannot as yet be specially authenticated, although G. Bischoff has already done much with reference to it. The depositions in the fissures ensued at first very energetically and under continued disturbances, whence arises their breccia-form and the massiveness of their contents; while later, with a decreasing temperature and less disturbances, and with slower deposition, the layer-like form gradually made its appearance. Vapour- and gas-streams may have occurred later, in place of the slow continuous circulation of water, and accumulated in drusy cavities or more recent sublimation-clefts, or, by a change in existing contents, have introduced metamorphism and translocation. But as, according to this theory, the deep-lying porphyry-masses are the original bearers of the contents of the Freiberg ore-veins, it should incite us to a further investigation, which might besides be important in a practical point of view.

The best examination would be if we could penetrate, by means of boring or by shafts, to a very great depth in some ore-districts, in order to reach the ore-bearing eruptive rocks, or a more richly metalliferous portion of the same. The stock-formed massive-rocks already metalliferous at the surface—for example, the Zinnstockwerke or the Bräunsdorfer ore-bearing porphyries—might be best adapted for such an investigation. The problem would be worthy of a country, the mining-operations of which are amongst the most important branches of its industry. Certainly, on the other hand, the consideration may arise, that the slower cooling at the greater depths may have accelerated still more the sinking down of the metallic particles.

Let us now throw back a general glance. Our theory explains very well why the newer eruptive rocks (trachyte, phonolite, basalt, lavas) are much more rarely accompanied by ore-veins than the older ones, and especially why ore-veins seldom occur in the newer sedimentary formations, even where these, as in the Alps, are often broken and penetrated by eruptive formations. It explains it, since according to it the progressive cooling of the earth as a whole must have caused the zone of the deposition (determined by the temperature) of the most abundant and notable constituents of ore-veins to have sunk deeper below the surface of the earth. If, besides, the whole phenomena of ore-vein-formation in volcanic districts still continue, they can, judging by the analogy of the old ore-vein-formations, only be going on at a considerable depth beneath the surface. Only some constituents are projected to the surface in recent volcanic fissures, such as Silica, Calc-spar, and Oxide of Iron; these in ore-veins partly extend throughout all periods, and partly occur only as the most recent or uppermost members (as gozzans), being, consequently, in the latter case deposited at a relatively lower temperature.

The ironstone-veins, filled partly by means of sublimation (as specular iron-ore), and partly by means of infiltration (as hydrated oxide of iron), are the only ore-veins which we can at present, in a measure, see originate. They are precisely, also, of all ore-veins the most frequently combined with the newer eruptive rocks, for example, the basalt formation.

Tin-ore and platina seem hardly ever to occur in those veins which have originated purely by infiltration, although the first has been found in the Freiberg copper-veins and in the Annaberg silver ones; and the spaces, too, of felspar-crystals in the granite of Cornwall can evidently have only been filled by infiltration, or sublimation. These metals belong, perhaps, principally to certain massive rocks as accessory constituents, out of the *detritus* of which are often derived the portions of those metals found in washings. Originally they occurred in common with the other metals, but it seems to be a peculiar characteristic of their nature that they do not occur in purely infiltration-veins.

NOTES ON THE ABOVE MEMOIR.

As Professor Cotta pre-supposes on the part of his readers a general acquaintance with the subject of mineral-veins and the difficulties which beset the solution of their theory, the force of many of his observations may not be remarked by those to whom this knowledge is not familiar. For the benefit of such I have jotted down the following notes which, while serving to elucidiate this memoir, may also be useful as indicating some of the difficulties that beset the subject, and some of the more important preliminary problems necessary to be solved.

I. *Relation between crystalline and eruptive rocks and metalliferous-deposits.*—Prof. Cotta's reasoning is entirely founded upon the generally observed relation between crystalline and eruptive rocks and metalliferous deposits. That this relation is a nearly constant fact seems to be beyond doubt, although there are occasional exceptions—not, however, sufficiently numerous to destroy the force of the observed relations, which have passed into a proverb in most mining-districts. But merely observing the fact of this relation is one thing, and accounting for it in a satisfactory manner is another. The first has been done universally; the second has never been seriously attempted, and probably, in the present state of our knowledge, is a problem impossible of solution. The most we can do is, as Prof. Cotta has done, to suggest such a probable hypothesis, as may be useful in giving a definite direction to our ideas and to our investigations.

II. *Whence are the metal-contents of ore-deposits derived?*—This question is the first difficulty we have to grapple with, and it has been fruitful of hypotheses. The Wernerian theory that the contents of veins (the most common form of metalliferous deposit) were derived from above has been universally abandoned. There remain two others: one, that these deposits originate by segregation from the neighbouring rock; and the other, that they are derived, by some means or other, from beneath. The segregation theory is one well worthy of consideration, and undoubtedly applies to many metalliferous deposits; but it still leaves unsolved the main problem of the original source of the metals; for it completely fails to account for the abundant distribution of the metallic ores in some districts, while in others, in the same class of rock, they are entirely absent. To account for all metalliferous deposits by segregation, irrespective of any other cause, we should have to have recourse to the alchemic doctrine of the possible transmutation of earths into metals. The theory of the metallic ores from beneath, has been suggested in every form; and is not without many difficulties to which I shall refer further on.

III. *Various forms of metalliferous deposits.*—Next to the question of the metallic ores, we are met with difficulties depending on the *forms* in which they are usually found. They generally occur in abundance in veins of a definite size and direction—the direction being constantly associated, in certain districts, with characteristic ores. But they are also found in forms that are not veins, such as in "stocks," or in irregular and indefinite masses. Veins are not peculiar to ore-formations, but are found in almost every rock, and include every kind of mineral species. Still, as from their nature, veins are hidden far from our sight; we only become intimately acquainted with them when they consist of such minerals that the necessities of man lead to their exploration. Hence our knowledge of veins is principally confined to those containing ores, or other veins associated with them; and we are often consequently led, very erroneously, to imagine that no veins exist but ore-veins, or those connected with them, and to limit the occurrence of minerals in the peculiar *form* we denominate veins exclusively to minerals of the useful metals: an idea productive of considerable misapprehension and confusion.

IV. *Most mineral-veins were fissures, subsequently filled.*—This is almost universally received as an established fact, although it seems to be objected to in some English mining-districts by "practical" men. There can be no question as to its truth, which is demonstrated in numberless cases beyond all doubt; but, with respect to it, we must guard ourselves against supposing that *all* veins or "lodes" have such an origin. Of course I here use the word *vein* in its proper sense, and not as a necessary synonym of a re-filled fissure, as it is in some cases employed. Used in this sense, I shall in the next paragraph refer to a class of veins originating otherwise. The objections referred to above originated from an imperfect acquaintance with the general principles of physical geology, without a knowledge of which it is useless to attempt to deal with the subject of mineral-veins, which, as Prof. Cotta remarks, are not "to be regarded as an isolated phenomenon." If we consider, for one moment, the great revolutions of upheaval and subsidence that every portion of the surface has undergone during ascertained geological periods, all of which, whether occuring by gradual or spadmodic movements, must have caused rents, we have no reason to be surprised at the existence of fissures.

V. *But all metalliferous-veins were not fissures.*—There are some metalliferous veins, "lodes," or channels that we meet with which cannot be regarded as re-filled fissures. Considerable confusion has existed on this point; for it has been held, but rather rashly, that a metalliferous deposit must be either a re-filled vein-fissure, or a strictly stratified deposit thrown down contemporaneously with the embedding strata itself, like beds of coal, or rock-salt. The difficulties and improbabilities connected with the latter hypothesis, have led to the acceptance of the supposed alternative of a "fissure" theory, which would not have been otherwise suggested by the individual facts. But more recent investigations in this direction now tend undoubtedly to show that such deposits may have arisen, without any original fissure, by a slow metamorphic action gradually replacing the original rock-constituent by the now-found metallic-ore. That under certain circumstances such changes have taken place, and are even at present slowly taking place by aqueous agency, seems now to be demonstrated, although of course the difficulty as to the source whence the metal is derived still remains.

VI. *Contents of veins varying with direction.*—No circumstance connected with metalliferous deposits has been productive of more difficulty than this. Whether filled from above, or below, or by segregation, it seems at first sight unaccountable how two sets of veins in the same district—one running north and south, and the other east and west—should differ completely in their contents. Yet such is often the case; and a fact so unaccountable has been the source of more mysticism than any other connected with the theory of ore-veins. It has been freely attributed to some occult action of electricity, or "polar forces," whatever that phrase may mean, and similar hypothetical causes. It must be understood that no *general* relation between the contents of veins and their direction has been established, although it seems to be asserted by some persons that such a relation does exist. The only known relation is a *local* one. For instance, in Cornwall and Devon lead-ores are contained in north and south veins, and not in east and west veins; whereas, in the lead-district of central Wales the ores of that metal are found abundantly in east and west veins.

VII. *Theory of Vein "Formations."*—According to this theory veins of certain classes were considered essentially characteristic of certain geological ages—were absolute "formations" in its geological sense of synchronous. It supposed special periods in the earth's history to have been marked by special metallic emanations which entirely passed away with those periods, of which they were characteristic. This doctrine may be compared to the very similar one that all granite was primitive; and experience shows us that the one is as unfounded as the other. Analogous metalliferous deposits may have been produced at widely removed geological periods. When we speak then of older, or of more recent veins, we refer not to their *absolute* but to their *relative* age in the same locality; or, when speaking of widely removed localities, we only refer to age with reference to other veins in each respective locality.

(To be continued).

BRITISH ASSOCIATION MEETING.

The 29th Meeting of the British Association opened on the 14th instant at Aberdeen, under the presidency of His Royal Highness the Prince Consort. The day following the various Sections were opened, that of Geology being under the presidency of Sir Charles Lyell. In his opening address, he said,

"No subject has lately excited more curiosity and general interest among geologists and the public than the question of the antiquity of the human race; whether or no we have sufficient evidence to prove the former co-existence of man with certain extinct mammalia, in caves, or in the superficial deposits commonly called drift or '*diluvium*.' For the last quarter of a century the occasional occurrence in various parts of Europe of the bones of man, or the works of his hands, in cave-breccias and stalactites associated with the remains of the extinct hyæna, bear, elephant, or rhinoceros, have given rise to a suspicion that the date of man must be carried further back than we had heretofore imagined. On the other hand, extreme reluctance was naturally felt on the part of scientific reasoners, to admit the validity of such evidence, seeing that so many caves have been inhabited by a succession of tenants, and have been selected by man as a place not only of domicile, but of sepulture, while some caves have also served as the channels through which the waters of flooded rivers have flowed, so that the remains of living beings which have peopled the district at more than one era may have subsequently been mingled in such caverns and confounded together in one and the same deposit. The facts, however, recently brought to light during the systematic investigation, as reported on by Dr. Falconer, of the Brixham Cave, must, I think, have prepared you to admit that scepticism in regard to the cave-evidence in favour of the antiquity of man had previously been pushed to an extreme. To escape from what I now consider was a legitimate deduction from the facts already accumulated, we were obliged to resort to hypotheses requiring great changes in the relative levels and drainage of valleys, and, in short, the whole physical geography of the respective regions where the caves are situated—changes that would alone imply a remote antiquity for the human fossil remains, and make it probable that man was old enough to have co-existed at least with the Siberian mammoth. But in the course of the last fifteen years another class of proofs have been advanced in France in confirmation of man's antiquity; into two of which I have personally examined in the course of the present summer, and to which I shall now briefly advert. First, so long ago as the year 1844, M. Aymard, an eminent palæontologist and antiquary, published an account of the discovery in the volcanic district of Central France of portions of two human skeletons (the skulls, teeth, and bones) embedded in a volcanic breccia found in the mountain of Denise, in the environs of Le Puy en Velay; a breccia anterior in date to one at least of the latest eruptions of that volcanic mountain. On the opposite side of the same hill the remains of a large number of mammalia, most of them of extinct species, have been detected in tufaceous strata, believed, and I think correctly, to be of the same age. The authenticity of the human fossils was from the first disputed by several geologists, but admitted by the majority of those who visited Le Puy and saw with their own eyes the original specimen now in the museum of that town. Among others M. Pictet, so well known to you by his excellent work on palæontology, declared, after his visit to the spot, his adhesion to the opinions previously expressed by Aymard. My friend, Mr. Scrope, in the second edition of his 'Volcanos of

Central France,' lately published, also adopted the same conclusion, although after accompanying me this year to Le Puy, he has seen reason to modify his views. The result of our joint examination, a result which I believe essentially coincides with that arrived at by M. Hébert and M. Lartet, names well known to science, who have also this year gone into this inquiry on the spot, may thus be stated. We are by no means prepared to maintain that the specimen in the museum at Le Puy (which unfortunately was never seen *in situ* by any scientific observer) is a fabrication. On the contrary, we incline to believe that the human fossils in this and some other specimens from the same hill were really imbedded by natural causes in their present *matrix*. But the rock in which they are entombed consists of two parts, one of which is a compact, and for the most part thinly laminated stone, into which none of the human bones penetrate; the other containing the bones is a lighter and much more porous stone without lamination, to which we could find nothing similar in the mountain of Denise, although both M. Hébert and I made several excavations on the alleged site of the fossils. M. Hébert therefore suggested to me that this more porous stone, which resembles in colour and mineral composition, though not in structure, parts of the genuine old breccia of Denise, may be formed of the older rock broken up and afterwards re-deposited, or as the French say, *remané*, and therefore of much newer date—an hypothesis which well deserves consideration; but I feel that we are at present so ignorant of the precise circumstances and position under which these celebrated human fossils were found, that I ought not to waste time in speculating on their probable mode of interment, but simply declare that in my opinion they afford no demonstration of man having witnessed the last volcanic eruptions of Central France. The skulls, according to the judgment of the most competent osteologists who have yet seen them, do not seem to depart in a marked manner from the modern European, or Caucasian type, and the human bones are in a fresher state than those of the *Elephas meridionalis* and other quadrupeds found in any breccia in Denise which can be referred to the period even of the latest volcanic eruptions. But while I have thus failed to obtain satisfactory evidence in favour of the remote origin assigned to the human fossils of Le Puy, I am fully prepared to corroborate the conclusions which have been recently laid before the Royal Society by Mr. Prestwich, in regard to the age of the flint-implements associated, in undisturbed gravel in the north of France, with the bones of elephants at Abbeville and Amiens. These were first noticed at Abbeville, and their true geological position assigned to them by M. Boucher de Perthes, in 1849, in his 'Antiquités Celtiques,' while those of Amiens were afterwards described, in 1855, by the late Dr. Rigollet. For a clear statement of the facts, I may refer you to the abstract of Mr. Prestwich's memoir in the Proceedings of the Royal Society, for 1859, and I have only to add that I have myself obtained abundance of flint-implements (some of which are laid upon the table) during a short visit to Amiens and Abbeville. Two of the worked-flints of Amiens were discovered in the gravel-pits of St. Acheul, one at the depth of ten, and the other of seventeen feet below the surface, at the time of my visit; and M. Georges Pouchet, of Rouen, author of a work on the 'Races of Man,' who has since visited the spot, has extracted with his own hands one of these implements, as Messrs. Prestwich and Flower had done before him. The stratified gravel, in which these rudely-fashioned instruments are buried, resting immediately on the Chalk, belongs to the post-pliocene period, all the fresh-water and land-shells which accompany them being of existing species. The great number of the fossil instruments which have been likened to hatchets, spear-heads, and wedges is truly wonderful. More than a thousand of them have already been met with in the last ten years, in the valley of the Somme, in an area fifteen miles in length. I infer that a tribe of savages, to whom the use of iron was unknown, made a long sojourn in this region; and I am reminded of a large Indian mound which I saw in St. Simond's Island in Georgia —a mound ten acres in area, and having an average height of five feet, chiefly composed of cast-away oyster-shells, throughout which arrow-heads, stone-axes, and Indian pottery are dispersed. If the neighbouring river, the Alatamaha, or the sea, which is at hand, should invade, sweep away, and stratify the contents of this mound, it might produce a very analogous accumulation of human implements, unmixed, perhaps, with human bones. Although the accompanying shells are of living species, I believe the antiquity of the Abbeville and Amiens flint-instruments to be great indeed if compared to the times of history or tradition. I consider the gravel to be of fluviatile origin, but I could detect nothing in the structure of its several parts indicating cataclysmal action; nothing that might not be due to such river-floods as we have witnessed in Scotland during the last half century. It must have required a long period for the wearing down of the chalk which supplied the broken flints for the formation of so much gravel at various heights, sometimes one hundred feet above the present level of the Somme; for the deposition of fine sediment, including entire shells, both terrestrial and aquatic; and also for the denudation which the entire mass of stratified drift has undergone, portions having been swept away, so that what remains of it often terminates abruptly in old river-cliffs, besides being covered by a newer unstratified drift. To explain these changes I should infer considerable oscillations in the level of the land in that part of France—slow movements of upheaval and subsidence, deranging, but not wholly displacing, the course of the ancient rivers. Lastly, the disappearance of the elephant, rhinoceros, and other genera of quadrupeds now foreign to Europe, implies, in like manner, a vast lapse of ages separating the era in which the fossil implements were formed and that of the invasion of Gaul by the Romans. Among the problems of high theoretical interest which the recent progress of geology and natural history has brought into notice, no one is more prominent, and at the same time more obscure, than that relating to the origin of species. On this difficult and mysterious subject a work will very shortly appear by Mr. Charles Darwin, the result of twenty years of observation and experiment in zoology, botany, and geology, by which he has been led to the conclusion that those powers of nature which give rise to races and permanent varieties in animals and plants are the same as those which, in much longer periods, produce species, and, in a still longer series of ages, give rise to differences of generic rank. He appears to me to have succeeded, by his investigations and reasonings, to have thrown a flood of light on many classes of phenomena connected with the affinities, geographical distribution, and geological succession of organic beings, for which no other hypothesis has been able, or has even attempted to account. Among the communications sent into this section, I have received from Dr. Dawson, of Montreal, one confirming the discovery which he and I formerly announced, of a land-shell, or pupa, in the Coal-formation of Nova Scotia. When we contemplate the vast series of formations intervening between the tertiary and carboniferous strata, all destitute of air-breathing mollusca, at least of the terrestrial class, such a discovery affords an important illustration of the extreme defectiveness of our geological records. It has always appeared to me that the advocates of progressive development have too much overlooked the imperfection of these records, and that consequently a large part of the generalizations in which they have indulged in regard to the first appearance of the different classes of animals, especially of air-breathers, will have to be modified or abandoned. Nevertheless, that the doctrine of progressive development may contain in it the germs of a true theory, I am far from denying. The consideration of this question will come before you when the age of the white sandstone of Elgin is discussed—a rock hitherto referred to the Old Red, or Devonian formation, but now ascertained to contain several reptillian forms, of so high an organization as to raise a doubt in the minds of many geologists whether so old a place in the series can correctly be assigned to it."

Sir RODERICK I. MURCHISON delivered a discourse "On the Geological Structure and Order of the Older Rocks in the Northern Counties of Scotland," in which he explained the progress which had been made in the classification of the rocks of sedimentary origin in Scotland. He alluded to the great leaders of Scottish geology, Hutton, Playfair, and Hall, and his immediate predecessors, Jameson, M'Culloch, and others, and showed to how great an extent the chief point on which he was to insist—the metamorphism of sedimentary strata of various ages into crystalline rocks—had been ably illustrated by Hutton himself. After his day, however, mineralogy chiefly occupied the minds of geologists, and comparatively little progress was made for some years in geology as at present cultivated. With William Smith, however, a new era arose in England, and the proofs which that sagacious man brought forward to show that each sedimentary formation was characterized by organic remains peculiar to it, and that there existed a regular order of superposition from the older to the younger strata, were the true foundations or keystones of modern geology. Sir Roderick then gave a very full account of his researches in the northern counties of Scotland, and concluded by calling the attention of the meeting to the progress which was being made by the Geological Survey of Great Britain under his direction, and under the special management in the field of his friend Professor Ramsay. Exhibiting certain sheets of maps, on the six-inch scale, of the counties of Edinburgh, Haddington, and Linlithgow, which explained the outcrop of the coal and limestone of these tracts, he trusted that the staff of geological surveyors at present allotted to Scotland would be soon augmented, and in that case he hoped to live to see the day, if maps were only provided, when all the geology of Aberdeenshire and the north of Scotland might really be worked out with accuracy. The present effort was chiefly confined to the application of recognized general principles of classification to the elucidation of the order of the older rocks of the Highlands; and nothing more could be attempted until the country possessed maps, the north of Scotland being almost the only country in Europe without an accurate map, a melancholy fact, on which he insisted a quarter of a century ago, when the Association met in Edinburgh in 1834. On that occasion the Association, at his request, memorialized the then Government; and this state of matters was being rapidly wiped away as regards all the tracts to the south of the Grampians; and he hoped that the skill and energy of his friend Colonel James and the officers under him would be so warmly supported by Parliament and the public that Scotland would have before long a really good topographical map, without which no practically useful geological results could be worked out. Sir Roderick concluded his address by impressing upon the minds of those auditors who were not geologists the nature of the great difference between the formerly accepted notions of the order and equivalents of the older rocks of the north of Scotland, and those which he desired to establish by his reform, by pointing to two generalized diagrams. One of these, representing the old notions, exhibited a great central mass of rocks, termed gneiss, mica schist, quartz-rocks, with granites, porphyries, &c., flanked both on the east and the west coasts by Old Red conglomerates and sandstones. The other, on which he had previously lectured, exhibited the succession which had been evolved out of that which was previously an assemblage of crystalline rocks, distinguished only by their mineral characters, but undefined by their relative position and imbedded organic remains, and in which the rocks of the north-west coast were confused with those of the east coast.

Sir **Charles Lyell** moved a vote of thanks to Sir Roderick for the clear and admirable illustration he had given them of the Geology of Scotland, which Professor **Phillips** seconded, remarking on the high estimation in which Sir R. Murchison was held over half the globe as the master of the Silurian.

Sir **David Brewster**, as Vice-president of the Royal Society of Edinburgh, then presented the Brisbane Medal to Sir Roderick, an act that met with great applause from the audience.

The deputation of the council accompanying Sir David Brewster, consisted of Dr. Christison, Professors Allman and Balfour, and Mr. Robert Chambers; the latter addressed Sir Roderick in the following speech:—

"Sir Roderick Murchison,—The Royal Society of Edinburgh, viewing your late researches in the Highlands of Sutherland with an interest and admiration shared by the whole scientific world, has thought proper to vote to you the first example of a gold medal, founded by its respected President, Sir Thomas S. Brisbane, for remarkable scientific services. In the paper read by you to the Geological Society in December last, the Society sees an admirable instance of laborious investigation in connection with a Scottish field. You have, sir, succeeded in putting into a new and correct place in the geological series, a band of formations which, from the days of M'Culloch downwards, has attracted a large share of attention, both on account of its constituent materials and the magnificent scenery which it forms; and you have thus conferred a great favour upon your native country. It seems suitable that the Royal Society of Edinburgh, which heard the first speculations of Hutton and of Playfair, should take upon itself to stamp with the national approbation services so distinguished as yours. The Society, however, must not and cannot overlook the fact that your researches in Sutherlandshire only follow up a most remarkable series of geological investigations performed during the last thirty-five years, and which have placed you so high among the great chiefs of living British geologists. In succession, the mountains of Auvergne, the Alps, the Carpathian, the Urals, have owned your genius for research. You have recalled to the world the story of the first ages of life upon its surface. In the wide plains of Russia your diligence has been as conspicuously shown as in that Siluria which is all your own. Two superb and voluminous works and a hundred separate memoirs but faintly express the amount of your geological writings. Nor, on the present occasion, should your services, as the head of the Geological Survey, and as the frequent President of the Geographical Society, be forgotten. Neither should we fail to remember that remarkable triumph of science of which you are the instrument—the vaticination of an auriferous region in Australia from the observations you had made in the Ural Mountains. Viewing these many merits and your present active course, the Royal Society of Edinburgh cannot but feel proud in having the privilege of conferring upon you the first Brisbane prize; and it is their earnest wish and prayer that you may long be spared to enjoy the many deserved honours which a grateful country and an admiring band of fellow-labourers and a beneficent Sovereign have conferred upon you."

Sir **Roderick Murchison** replied in very feeling language, that no honour ever conferred upon him had touched him more than this testimonial at the hands of his own countrymen. He was gratified beyond measure at receiving this honour from a Society which, of all others in Europe, is most chary in conferring its honours, and has a more limited number of honorary members. And all the more would it be esteemed that it was put into his hand by one of the most eminent of living philosophers.

The following is a summary of the other papers read in the Geological section:—

Dr. Black, F.G.S., "On Coal at Ambisheg, in the Island of Bute."

Mr. W. H. Baily, F.G.S., Palæontologist to the Irish Geological Survey, "On Sphenopteris Hookerii and Ichthyolites, from Kiltorkan Hill, Kilkenny."

Dr. Brice, "Notice of the discovery of Upper Silurian Fossils in the Devonian Slates."

Dr. Anderson, of Newburgh, "On the Remains of Man in the Superficial Drifts." His main object in bringing the subject before the meeting was to give a condensed view of the discovery of human remains in the superficial accumulations of pre-historic origin. Undoubted cases existed of human remains enclosed in hard compact concretionary rocks, buried deep in the silts of rivers, and high up in caverns, associated with the bones of elephants, lions, tigers, hyenas, and other extinct carnivora. As to the instances occurring in the beds of lakes, rivers, and seas, he contended that a few years, or even months, often sufficed for the formation of a compact durable mass of calcareous and siliceous rock, in which human bones, skeletons, pottery, coins, and implements were embedded. He referred to a case betwixt Aberdour and Burnt-island, in Fife, which he examined a few weeks ago, where an incrustation was now forming of great depth, in which are embedded land-shells, branches of trees, and where on the face of the encrusted cliff, twigs of living trees are becoming entangled in the calcareous breccia. The Rev. Doctor quoted the case of a cannon-ball—a 32-pounder—lately presented to him by a fellow-townsman, deeply encrusted with ferruginous mud, and completely indurated, which was raised by an anchor in the harbour of Copenhagen. The skulls at Amiens and Abbeville, the remains in the caverns of Torquay, and those in Scilly, the flint-weapons in veined-limestone in Cantyre, and the arrow-heads with elephant-remains in Suffolk, were then successively brought under review. He saw no evidence deducible from the superficial drifts to warrant a departure from the usually accepted data of man's very recent introduction upon the earth.

Mr. Henry C. Hodge, "On the Origin of the Fossiliferous Caves of the Plymouth Limestone." The author traced the origin of the caves to the decomposition of a variety of irregularly-distributed dolomite containing the carbonates of iron and manganese; and expressed an opinion, from an examination of the geological position of the limestone and its relations to surrounding rocks, that at the time the bone-caves were formed they must have been situated at a much higher level than at present, and contained no stalagmite during their habitation by carnivora. He attributed the introduction of the remains in the caves to the agency of carnivorous cave-inhabiting animals; but admitted that in some previous instances the evidence appeared to show that the animals had fallen into fissures. He adduced facts which, he thought, showed that the bone-caves had been re-opened for the admission of stalactite after the enclosure of their ossiferous contents, and he argued that the facts, if properly considered, would help to demonstrate that not merely was there no geological evidence whatever to prove the co-existence of the extinct animals with man, but that all the apparently powerful arguments based upon the occurrence of his remains in ossiferous caverns might be merely deceptive, and of no real significance or certainty whatever, as their presence in them might be easily accounted for through the operation of still existing causes.

Mr. D. Page, F.G.S., gave in a report on the exploration of the Upper Silurians of Lesmahagoe, in terms of the Association's grant to Mr. Slimon. During the last summer Mr. Slimon and his son had diligently explored the fossiliferous tract of Upper Silurian strata in the parish of Lesmahagoe, and the result of their operations had been to exhibit still further the highly fossiliferous character of the Nilberry Silurians, and to give ample indication of a very varied and curious crustacean fauna, altogether new to palæontology.

The Rev. Dr. Longmuir, "On the Restoration of the Pterichthys."

Mr. D. Page next gave a brief and interesting Notice of some new Boreal forms of Mollusca from the Pleistocene deposits of Scotland.

Rev. W. S. Symonds, "On some Fishes and Tracks from the "Passage-rocks," and from the Lower Old Red Sandstone of Herefordshire."

Rev. H. Lloyd, "On the Affections of Polarized Light reflected from and transmitted by thin plates."

Professor Daubeney, F.R.S., "On certain Volcanic Rocks in Italy, which appear to have been subjected to Metamorphic Action."

Dr. M'Gowan, "On certain Phenomena attendant on Volcanic Eruptions and Earthquakes in China and Japan."

Messrs. Garner and Molyneux, "On the Coal-fields of Staffordshire."

C. Moore, F.G.S., "On Brachiopoda, and on the development of the loop in Terebratella."

Dr. Buist, F.G.S., "On the Geology of Lower Egypt."

The President read a letter from Dr. Dawson, F.G.S., intimating certain discoveries which he had made of a land-shell and reptiles in the South Joggins Coal-field, Nova Scotia, and enclosing two specimens.

Professor Nicol, F.R.S.E., gave an able and interesting notice on the "Relations of the Gneiss, Red Sandstone, and Quartzite in the north-west Highlands," illustrated by various sections. Professor Nicol had visited the Highlands, and had arrived at a different conclusion as to the succession of certain crystalline and sub-crystalline rocks from that arrived at by Sir R. Murchison. He contended that the great series of rocks in question were of older date than that assigned to them by Sir R. Murchison, and endeavoured to prove, by a reference to the sections which he exhibited, that the order of superposition which he advocated was the correct one.

Professor Huxley read a paper on "Newly discovered Reptilian remains from the neighbourhood of Elgin."

Rev. Professor Sedgwick, "On Faults in Cumberland and Lancashire." The object of the Professor's description of the faults in Cumberland and Lancashire was to show that there was really no violation of the order of superposition of the strata.

Professor Rogers, "Some Observations on the Parallel Roads of Glenroy," in which he described the leading features of the district, and indicated as his opinion that the shelves or grooves on the surface of the hills had been formed by water in motion, and not by water at rest, as had been supposed.

Professor Harkness, "On Sections along the Southern Flanks of the Grampians."

Mr. J. Wyllie, "On some Old Red Sandstone Fossils."

Mr. C. W. Peach, "On New Fossil Fish from Caithness."

Mr. W. H. Baily, F.G.S., "On some Tertiary Fossils from India."

Adolphe Radiguel, C.E., "On a Fragment of Pottery found in a Superficial Deposit."

M. Gages, "On the Results Obtained by the Mecanico-chemical Examination of Rocks and Minerals." M. Gages had invented a new mode of examining metamorphic rocks. Instead of reducing them to powder, he simply broke them down and then submitted them to chemical tests. By this means some remarkable results had been obtained.

Mr. C. G. Thost, "On the Rocks and Minerals on the Property of the Marquis of Breadalbane."

Mr. Brady, "On some Elephant-remains at Ilford." The chief of these was the tusk of an enormous mammoth, identical with the Siberian mammoth. Remains of coniferous and other plants yet existant were found in the same strata.

Mr. J. Miller, "On the Age of the Reptile sandstone of Morayshire."

Mr. D. Page, "On the Structure, Affinities, and Geological Range of the Eurypteridæ."

Professor Harkness, "On Yellow Sandstones of Elgin and Lossiemouth."

Rev. Dr. Longmuir, "On the Remains of the Cretaceous Formation in Aberdeenshire."

Mr. T. F. Jamieson, "On Drift-beds of the North of Scotland."

Mr. John Cleghorn, "On the Submerged Forests of Caithness."

Mr. Wm. Pengelly, F.G.S., "On the Ossiferous Fissures at Oreston."

Dr. G. D. Gibb, F.G.S., "On Canadian Caverns."

Mr. C. Moore, F.G.S., "On the supposed Wealden and other Beds near Elgin."

Rev. Dr. Anderson, "On the Dura-Den sandstone."

Mr. J. Miller, F.G.S., "On some New Fossils from the Old Red Sandstone of Caithness."

Mr. A. Geikie, F.G.S., "On the Chronology of the Trap-Rocks of Scotland."

Mr. H. C. Sorby, F.R.S., "On the Origin of Cone in Cone-structure."

Rev. H. Mitchell, "On New Fossils from the Lower Old Red Sandstone of Scotland."

T. F. Jamieson, Esq., "On the Junction of Granite with Stratified Rocks."

Professor Nicol, F.G.S., "On the Geology of Aberdeenshire."

Rev. Dr. J. Longmuir, "On Coast-section between Aberdeen and Dunnottar Castle."

NOTES AND QUERIES.

Banded Flints.—Dear Sir,—Amongst the flints of the Upper Chalk, I have met with some presenting bands of a whitish or grey substance, alternating in layers with the dark flint of which the nodules chiefly consist. These bands, or striæ, vary considerably in thickness; in some specimens being only a line in breadth, in others fully a quarter of an inch. Sometimes they may be distinguished on the exterior of the flints, exhibiting the appearance of a projecting spiral, or a series of discs. I have never found any two specimens offering any great degree of similarity. I should be obliged by your expressing an opinion upon this phenomenon in your valuable periodical. Yours &c., Silex, Luton, Bedfordshire.—Mr. N. T. Wetherell in a paper read before the Geological Society of London, in Nov., 1858, referred these banded-flints, from which the ringed forms have been produced by weathering and the action of water-wear, to a peculiar concretionary action in the consolidation of the silex into nodules. This paper was illustrated by a very large series of banded-flints, exhibiting the phenomenon both as sections and in the screw-like or weathered state. Such flints are abundant at Whetstone, Charlton, &c., and the weathered fragments are of very common occurrence in all drift-gravels.

Observations upon certain Geological Inferences.—Sir,—I should like to present your readers with a few remarks upon the subject of geological inference, inasmuch as it is one which appears to me to have been neglected, especially as regards the primary deductions upon which the science of Geology has been founded. The "logic of geology," although perhaps a novel is a very telling phrase, and may to many appear somewhat ironical, although the term logic when applied to any positive science cannot but seem just: if therefore this phrase excites somewhat unpleasant feelings in a competent mind, especially when certain parts of the science are considered, there is *à priori* reason for believing that some geological facts, or rather assumed facts, have not that consistency which strict logic demands, and are not therefore superior to ordinary hypotheses. From its nature, Geology can never attain that degree of certainty which characterizes the mathematical and other sciences; nevertheless, as far as possible, strict logic may dictate all its facts. That this is not the case now I will endeavour to show.

Supposing that a man should for the first time behold the various strata in a well, or appearing slantingly in an ordinary dyke, it is probable he would imagine three things:—1st, which was the oldest; 2, which was the earliest formed; and 3rd, were they originally placed as they now appear. These three questions strike me as forming the basis of geological science, as leading to the various ramifications into which this interesting inquiry is afterwards developed.

As regards the question of antiquity it is judged, and rationally enough, that the rock which is universally found as the basis of every other is the oldest; and this because it is absurd to suppose that the upper rocks and beds were first formed, and that the under-one was then miraculously (using this term of course in its highest sense) placed under them. This idea is quite un-needed, because the phenomenon can be explained in a simple and highly probable manner. Granite is this rock, and as it has never been found, which is for obvious reasons improbable, that any other rocks dip into it, no doubt as to its antiquity can remain; and this is absolutely confirmed upon considering that it is an igneous rock, and hence must have existed prior to its neighbours. The reasons of this are well known, or I should have given them.

To determine the periods of the formations of various rocks, every one will allow that we can only judge, if we judge at all, by the rate of time the like operations progress at in the present age. Now, I maintain that this is a very doubtful rule upon which to rear theories, or assumed-facts, of such moment as have been laid down by geologists; and I find that Dr. Brewster agrees with me, whose remarks upon this subject I shall take the liberty of quoting. He says, in "More Worlds than One," "It is taken for granted that many of the stratified rocks were deposited in the sea by the same slow processes which are going on in the present day; and as the thickness of the deposits now produced is a very small quantity during a long period of time, it is inferred that nine or ten miles of strata must have taken millions of years for their formation." I apply this scepticism to every rock either above or below the earth's surface since the commencement of human history. It cannot be said what time sedimentary deposits have taken to form, inasmuch as their present progress is no criterion. This may be denied, but the denial cannot be substantiated; whereas it is quite easy to suppose that such deposits have been formed very quickly. Hence this geological assumption is at the best an hypothesis, and in my opinion by no means a probable one. There is a logical flaw about it which renders it at once a matter of doubt. And if this notion of the high antiquity of the earth is put aside, there need be no controversy respecting the length of the days of creation: each day may coincide in duration with those of the present period. The world is in the Mosaic account said to have been created, and other changes follow, when we hear of the first day, from which I judge that all was effected within this period. But, to keep to the philosophical part of the question, I do not think that the antiquity of the world, which geologists presume, is at all substantiated, to say nothing of the use, and consequently wisdom of such an act.

The author I have quoted further remarks, "The dry land upon our globe occupies only one-fourth of its whole superficies, all the rest is sea. How much of this fourth part have geologists been able to examine? and how small seems to be the area of stratification which has been explored? We venture to say not one-fiftieth part of the whole, and yet upon the result of so partial a survey there has been founded a startling generalization. The intellectual races, if they did exist, must have lived at a distance from the ferocious animals that may have occupied the seas or jungles of the ancient world, and consequently their remains could not have been found in the ordinary fossiliferous strata. Their dwelling-places may have been in one or more of the numerous localities of our continents not yet explored, or in those immense regions of the earth which are now covered by the great oceans of the globe; and till these oceans have quitted their beds, or some great convulsions have upheaved and laid bare the strata above which the races in question may have lived and died, we are not entitled to maintain it as a demonstrated truth that the ancient earth was under the sole dominion of the brutes that perish." I confess I do not see that if intellectual races have existed prior to man, they must, as a matter of necessity, have lived at a distance from the ferocious animals which then peopled the world: they may have built habitations and fabricated instruments of defence. But as we find traces neither of these nor of themselves, and yet discover remains of pre-adamite animals, it must be concluded that the supposed intellectual races could not have resided amongst them. Yet I agree with Dr. Brewster that the generalization is hasty and unfounded; although far more probable than the former assumption, it is equally illogical. As a deduction it is quite as unsound.

As an illustration of the shutting-out of causes, if I may use such a term, and the reducing of all phenomena to a few, which has rightly been said to be a passion with philosophers, geologists have rather cut short the origin of springs and lakes. I think that the following explanation has never received a place among others: they may arise from cavities running inland from below the level of the sea, and terminating either upon or below the surface of the land, thus forming either springs or lakes. According to this hypothesis the depth of such a lake, for it is not said that all lakes and springs are thus formed, would be determined by the height of the land where the cavity or sandy passage reached its surface, and the height of springs would vary in the same manner; according to the depth of the sandy cavity below the level of the sea would be depth or height of lakes or springs thus formed, supposing this hypothesis be received as correct.

Proceeding to the third question, there is little difficulty in discovering that after convulsions have ruptured the once orderly arrangement of the sedimentary and igneous rocks, it is easy to perceive that mountain ranges have been caused by upheaval. This species of geological power produces flaws in the shape of contortions and faults, which volcanic power can alone bring to pass; the gradual enlargement and diminution produced by present stratification and disintegration produces regular series of rocks, wherein occur no faults or other imperfections. It is probable that when the earth was formed, the igneous rocks cooled so as to allow the materials of our present aqueous rocks to be gradually precipitated upon them. Hence regular strata would be the result, and for once assuming an hypothesis to be true, from this it must be that the various mountain-ranges were called into existence after this event, and that the defective strata which form them, and all which occur, are the work of after volcanic agency. It may be thought that I here condemn myself by assuming that which ought to be absolutely proved. But I would urge that such an inference as this is in the highest degree probable, and thus may be assumed as demonstrated, in which it differs, although only in degree, yet immeasurably from the inferences already noticed.

The development of this latter question has lead many to theorize altogether apart from experience, when no real advancement of knowledge has, from the nature of such a course of conduct, ensued. Logic has been separated from experience; men have argued metaphysically instead of physically; and thus, geological inferences, improperly so called, have rather provoked merriment than serious attention, which, combined with the habit of assuming no very probable conjectures for demonstrable truths, has rendered Geology somewhat unpopular even among professed men of science; and the term "logic of geology," or something similar, expressive more of ironical contempt than anxious expectation, or even the present condition of the science. But, throwing off every hasty habit, and discarding every hasty generalization, the student of geology will truly progress; for their's is a science happily capable of philosophical inference, and one which will amply repay the study devoted to it. I. A. Davies.—At all times we give insertion to any sensible remarks, whether they convey information or pourtray doubts or mis-comprehensions for solution. A wrong impression produced on one reflecting mind by a want of full information, or a wrong reading, or misunderstanding of abstruse facts may be produced on other minds in a like manner; and it is obviously one of the duties of a popular magazine on a special science at all times and on all occasions to set right its humbler votaries whenever any of them are doubtful or take a wrong view. Geologists well versed in the science would perceive at a glance some erroneous notions mixed up with our correspondent's not in-acute remarks on geological logic, but these points might not be so palpable to general readers.

There is no reason why Geology should not become ultimately one of the most logical of all the sciences, of which indeed it is a grand and wonderful combination, and consequently inherently partakes of all their mathematical and logical properties. But while geology is in so thoroughly progressive a state, completely logical deductions should not be expected to be produced from admittedly defective data. Upon insecure foundations no one can properly build up logical conclusions. We admit, however, that much that seems illogical in the writings of some modern geologists, might have presented a very different aspect by a little care on the part of those authors, and we have already referred to this carelessness of diction which tends to stamp our science with a want of logic. This is, however, only apparent and not real. The great doctrines of Geology based on a good ground-work of established facts are undoubtedly most logically deduced; and there is certainly nothing to prevent every minor detail, so aided as geology must ever be by chemistry, mathematics, natural physics, and other exact and deductive sciences, being as exact and definite. It is only just, therefore, to conclude that geology, a science compounded of exact and logical sciences, should be, if properly compounded, an exact and logical whole.

Now our correspondent, in his own example of reasoning, has gone wrong altogether in his facts chosen as a basis of attack upon geologists for want of logic. He has first thoroughly mistaken, or is altogether ignorant of the true nature and origin of granite. This rock is only a crystalline condition of rock, and in its *crystallized condition* may be of any age from older than the Cambrian, or lowermost sedimentary rocks, to the newest of the Tertiaries. He is not secure again in his statement that no rocks dip into it, if we understand his meaning to be that it is totally distinct from any connection with other and sedimentary formations; for certainly sometimes such sedimentary strata, if they do not plunge into it as a plank into a heap of mud, which from the nature of things is not to be expected, at least they sometimes lose their distinctive stratified characters as they approach a granitic boss, and gradually merge into its crystalline and peculiar mineral characters.

Again, with respect to the vast periods of time required for the formation of rock-strata, our correspondent is more illogical himself than any of the geologists he attacks, for they do carefully take as data those physical phenomena which are going on around them, and they do moreover in their application of those data to past conditions take great care to notice and to observe whether the appearances presented in the mineral conditions and physical aspects of the rock-strata, to which they thus apply them, are such as to indicate their having been formed under like or under dis-similar conditions; while our correspondent contents himself with a broad and unsubstantiated denial of all fact and fiction, and tells us it is quite as easy to suppose one thing as another, a conclusion it requires no great amount of logic to arrive at. Neither is there any logic whatever in his association of the length of the days of creation, as written in the Mosaic account, with the periods of time required by geologists for the development of the earth to its present conditions. The length of time the great rock-masses have taken in their formation, the length of time the earth has existed are the logical deductions from very exact and scrupulously examined data—data and deductions which have passed through the most violent and persecuting opposition, unrivalled only by the memorable attack upon the scientific truth developed by that foremost of astronomers, Galileo. Geology presents us in its statements on this topic with accurately logical deductions, but linguists and theologists have not presented us with the like exact and logical interpretations of Holy Writ. Geologists are labouring incessantly in the acquirement of new information, and have so far laboured incomparably more earnestly and incessantly to effect a reconciliation of these passages referred to than theologists themselves; and whenever the thorough harmony is effected, probability certainly points to the side of geologists as the accomplishers.

Our correspondent is again at fault as to the extent of territory examined by geologists. He ignores the great geological surveys which England, America, Holland, and other countries have established. He forgets how Englishmen, Frenchmen, Americans, and the citizens of every great and civilized country roam and travel over far-off lands, and bring back to us volumes of information long before the rolling tide of civilization reaches the shores of the remote lands they have explored. If every inch of ground is not probed to the quick, at least the general ostensible features of very vast extents of territory are as fully known as to satisfy the keen scientific observer that no great modification of his general deductions are required. Every new region penetrated by the adventurous explorer adds to the consolidation of the previous deductions, and confirms instead of shaking into doubtfulness.

In taking up his third point, our correspondent is far away indeed from a right comprehension of geological teaching. No one must think by the mere reading of one or two geological treatises that he can, as geology stands at this present time as a progressive science, arrive at a proper estimation or knowledge of that vast and stupendous science. It is perhaps only by the labour of a life-time, and under the divine blessing of a powerful intellect, that any man can become a thorough geologist. More intricate and labyrinthine even than astronomy is the science with which he has to deal. Time, the great feature of the one, is as boundless as space, the great feature of the other; and the knowledge of the phenomena of the depths below the surface of our globe is as difficult of acquirement as the penetration of the vision into the realms of the outer worlds around us. Astronomy must be limited by the capabilities of the telescope and the vibrations of the pendulum; but Geology is the physical history of our mother-earth from the first-days of its birth unto the end of time —it is a great volume which no man's life will suffice for the reading.

It is the difficulty often, so numerous are the ramifications of the data forming the groundwork upon which geological statements are made, of stating such ground-work concisely and explicitly that gives in many cases the appearance of illogical writing; and without going through the details of our correspondent's third and concluding portions of his communication, it will be easy for our readers to perceive how the *condensation*, in time, of the geological phenomena there referred to, as presented by him, gives at once an air of incoherence and improbability which renders palpable the falseness of the attempted logic applied. The moment we apply the medium time, we have no more such inconsistencies as rapidly precipitated rocks containing countless myriads of organic remains, but which were made up in fact not seldom of the ground-down and well-worn particles of beings that naturally lived and naturally died. With time brought in as an element, the volcano, intermittent in action and terrific in energy, seems to pour forth its volumes of molten lava over the surfaces of former lands, and ever and anon the subterranean force heaves up the ground, and combats with the destruction of the ever-wasting sea.

There is nothing in the grand conclusions of Geology to excite *merriment;* it is a pious and a holy study, and if not undertaken in such a spirit had better be left alone. If anywhere it be unpopular, it must be where ignorance or silly timidity prevails, and not where truthfulness and investigation find earnest votaries; if its knowledge is not more widely spread it is only because the state of education is not sufficiently advanced for its beauties and sublimities to be properly understood, or because men want time for its proper pursuit. No one with a mind duly capable of reflection and of elevated thought can feel indifferent to the history of the earth on which he dwells, and over which his race reigns predominant.

We have printed our correspondent's communication, however, in its entirety, considering his general remark of a seeming want of logical inference to be in many cases just, as far as the mere appearance goes, and as being a valuable hint to obscure writers to improve their styles of composition for the benefit of those who peruse their works, as well as for the general advantage and progress of knowledge.

CHALK-SPONGES OF YORKSHIRE.—DEAR SIR,—Noticing in No. 13 of your Magazine the request for a paper on the Sponges from the Yorkshire Chalk, I beg to state that steps are about to be taken by me to ensure faithful drawings of all the species of those curious fossils, of which I have been collecting specimens for the past twenty years.

I am now making a selection which I intend to have drawn, and to publish with a short account of the localities where they were found, so as to enable visitors and amateur-geologists to obtain such fossils themselves.

I believe that there is not any work which contains figures of one tenth-part of the species met with, and many of the forms are not, as yet, placed in the museum-collections at York, Hull, or Scarborough.

I shall have much pleasure in showing my collection to geologists visiting this town.—Yours, &c., EDW. TINDALL, Bridlington.

FIRST BRITISH FOSSIL BEAVER.—As all notices of mammalian remains appear to be of value at this period of most interesting investigations, I have sent you an abstract of one by Mr. I. Okes, from the "Transactions of the Cambridge Philosophical Society" for 1822, of the first fossil beaver found in England.

From all that has been recorded by naturalists of the abode and habits of the beaver, as also from its anatomical peculiarities, it is generally concluded that the fossil beaver of this country is not only of the same, or a nearly allied species as the existing kind, but that it has once been indigenous to Great Britain.

The fossil remains referred to in Mr. Okes paper consist of the left halves of two lower jaw-bones and other portions of four skulls, dug up in 1818 by a workman about three miles south of Chatteris, in Cambridgeshire, in a bed of the old West Water, formerly a considerable branch of communication between the Ouse and the river Nen, but which, according to the fen-people, has been choked up for more than two centuries.

The accuracy of this tradition is proved by the following order of Council, printed in Dugdale's "History of the Fens."

"Anno 1617, 9 Maii, 15 Jac.—That the rivers of Wisbeche and all the branches of the Nene and West Water be cleansed and made in bredth and depth as much as by antient record they have been."

The bones above referred to were taken from a peat-soil of a dark brown colour.

In the same paper is a notice of a part of an elephant's skull with two grinders, and fragments, two feet in length, of the horns of a large species of deer, supposed to be those of megaceros by the author. These last mentioned fossils, the author observes, have no connection with the remains of beaver, but were found in a stratum of clay half a mile eastward of Chatteris, of the antiquity of which he can form no idea, whereas those of the beaver belong to a stratum which he thinks may be referred to a period not very distant even in the history of our country.

The titles of the plates describe the specimens as then being in the possession of Prof. E. D. Clarke, of Cambridge.—I. A. B.

The Third and Fifth Days of the Mosaic Narrative.—When examining the Silurian rocks in the south of Scotland, a fact has often struck me which I am at a loss to understand. The whole of the organic remains found in these rocks, with the exception of marine algæ, were, according to the Mosaic narrative, creations of the fifth day; the terrestrial vegetation, according to the same authority, was created on the third day. Notwithstanding, we find no trace of the third day's creation in any of the Silurian formations, and very few in the Devonian, and not until we enter on the Carboniferous system (formed thousands of centuries after the Silurian) do the "grass and herbs yielding seed and the fruit-trees yielding fruit" appear. Any of the readers of The Geologist, harmonizing the two teachings, would confer a favour on Argus.—Land-plants have left their remains in the upper Silurian, and, for what we know, in the Lower Silurian too, at least we have as low down as the horizon of the Lingula-flags veins of anthracite and bituminous exudations, although we can not yet positively state the sources from which those substances have been derived. Land-plants are plentiful in some Devonian beds both in the British Islands, Europe, and in North America.

Live Lizard imbedded in a Seam of Coal.—In the month of August, 1818, when the workmen were sinking a pit at Mr. Fenton's colliery near Wakefield, and had passed through measures of stone, grey "buist," blue stone, and some thin beds of coal, to the depth of one hundred and fifty yards, they came to the seam of coal, about four feet thick, which they proposed to work. After excavating about three inches of it, one of the miners struck his pick into a crevice, and, having shattered the coal around into small pieces, he discovered a lizard about five inches long. It continued very brisk and lively for about ten minutes, and then drooped and died.—See "Philosophical Magazine," vol. lii., p. 377. (C. J.)

Collecting Fossils from Workmen.—Dear Sir,—Could you inform me in your next number what is a fair price to pay workmen in Chalk-pits for such fossils as Cidaris, Cyphosoma, Spondylus, sharks' teeth, fish, &c.? I was informed that a penny each was the regular charge, but I can only obtain the commonest fossils, as Micraster, Galerites, Pecten, or Terebratula, at this price. —Yours truly, C. Evans, Hampstead.—We have frequently bought common and refuse fossils of quarrymen in obscure localities at the prices named, but in pits where the workmen are sought after for the fossils they obtain in their daily labours, the prices, from the very fact of there being a ready market for those articles, naturally rise. Neither do we think it fair to the workmen, if they take pains to obtain good specimens, to attempt to buy their better and rarer fossils for less than a fair price. Many specimens bought for a few pence are prized by their purchasers when placed in their cabinets at as many shillings or even pounds. We have, however, often spoken out as to the money-value of fossils. They have no real money-value, and to collect, through the medium of workmen, good fossils, there is only one way of succeeding, and that is to encourage the most intelligent of them in any special locality, and to recompense them liberally for submitting all they obtain at first-hand and intact to your notice.

Class-Lectures on Geology.—Sir,—Can you kindly inform me of any class for the acquisition of the science of Geology, as I wish to devote my leisure to it. I would not have troubled you, but I find the evening classes at King's College do not comprehend this science within their course of study; that at the Working Man's College also it is not taught. Where else to apply I know not, and as, from the popular character of your periodical, I judge you may possibly be better acquainted with such classes than most men, I have ventured to trouble you. A reply on the cover of next month's Geologist will much oblige, E. H., Hackney.—Class-lectures for geology and palæontology were commenced during their last session at the rooms of the Geologists' Association, 5, Cavendish-square, and will be continued during the ensuing and future seasons. We regret E. H. did not think fit to entrust us in confidence with his name, as we could then have communicated every particular to him by post. It is not our practice to answer queries on the wrapper of our Journal; and although we did so last month in answer to E. H., we shall not break through our rule in any future instances; nor shall we feel ourselves at all bound to notice purely anonymous communications. We suppress the names of our correspondents on all occasions when required to do so, but the absence of the private communication to ourselves, as in this case, frequently causes needless trouble and expence, especially when the queries reach us late in the month.

Weathered Rocks, near Keswick.—A very interesting communication from Mr. T. Rupert Jones in No. 20 of The Geologist relating to the "weathering" of granite-rocks, has reminded me of what I observed on a late visit to Keswick in the surrounding scenery. I remarked that the masses, great and small, of the prevailing rocks, Silurian and igneous, strewed around on the sides of the mountains and in the valleys and ravines exhibited an amount of *rounding-off* of their angles, equalling that of the boulders of primitive and secondary rocks met with in the drift of the eastern counties; and as these masses cannot have experienced the attrition or friction consequent on transportation, their bouldered-state must be the result of *weathering*.

During the same ramble I remarked to a companion how much the summits of some of the mountains resemble craters in volcanic districts, except that they were too small for the result of volcanic action. If I recollect rightly, I particularly observed one near Buttermere, on my way to Keswick, through Newlands, as looking towards the Mere. Probably these hollows have resulted similarly to those mentioned by Sir Henry de la Beche in a note on the "Report on Cornwall, Devon, and West Somerset," and their cause explained by Mr. Ormerod in his table of Tors and Rock-basins.[*] As it is probable that many of your readers have not heard of the "Bowder-Stone" in Borrowdale, I will give an account of its magnitude as recorded in a hand-bill sold on the spot. The dimensions are as follows, viz., length 62 feet, perpendicular height 36 feet, circumference 89 feet. It contains 23,090 solid feet, and weighs 1971 tons 13 cwt.

Bowder-stone, as above written, is of course a corruption of Boulder-stone, or Bowlder-stone, as Webster has it in his dictionary. I send these few words for the use of juvenile geologists, that they may not interpret the above detached and scattered masses of rock as they should the boulder-masses in the drift.—Yours, &c., GREAT YARMOUTH.

---

[*] The Geologist for August, pp. 309—310.

FOSSILS FROM GIRVAN, AYRSHIRE.—SIR,—I shall be obliged if you can give me any information about the deposits in the immediate neighbourhood of Girvan, Ayrshire. Some fossils from a limestone-quarry there were sent me by a friend. They appear to be a species of Euomphalus; but from the manner in which they have been extracted from the quarry, only one side can be examined, the other being embedded in the limestone. I should be much obliged if you could inform me whether the limestone-deposits of Girvan belong to the mountain-limestone or to the Silurian period.—Yours, &c., W. M. B. A.—In 1850 Sir Roderick Murchison and Professor James Nicol devoted some time to the examination of the Girvan neighbourhood, and the result was a memoir, illustrated by a map, sections, and plates of fossils, in the Geological Society's Journal (No. 27, vol. vii.) From this memoir we learn that the limestones at Craighead, Assel Burn, Aldeans, Craigneil, and Bogang are of Lower Silurian age; and that the limestones south-east of Mullock Hill, and at Lemmy-lane are Carboniferous.

The Euomphalus-looking fossil may possibly be a Maclurea, which is characteristically a Lower Silurian fossil, and is found near Girvan.

ARTIFICIAL NODULES: VENUS'-HAIR STONE.—SIR,—I trust you will excuse my again troubling with a few small specimens, which I shall be extremely obliged if you will name.

The shells were taken out of a kind of smooth, round nodule, composed of a soft, sandy material of which I enclose a portion. It was brought to me lately, having been purchased at Dover; its appearance was extremely artificial, being perfectly covered with small ammonites, shells, etc., embedded on the surface of this sandy nodule.

The small brooch of what is commonly called Venus'-hair I enclose, because I am anxious to know its composition. I have another larger specimen of which the coloured streaks, running transversely through one side of the crystal, are of a darkish brown colour, the crystal itself being perfectly clear, like the purest glass.—Yours &c., W. M. B. A., Mid-Lothian.—The nodules referred to are artificially made by mixing the dark green sand of the Upper Greensand of Eastwear Bay, near Folkestone, with gum or glue. Immersion in hot water will at once detect this fraud, for which one or two persons at Dover are notorious. The fossils stuck on the outside are the commonest Gault fossils obtained from Copt Point and Eastwear Bay, such as *Ammonites lautus*, *A. splendens*, *A. tuberculatus*, *A. varicosus*, *Hamites attenuatus*, *Nucula pectinata*, *N. ovata*, *Inoceramus sulcatus*, *I. concentricus*, *Dentalium decussatum*, *D. ellipticum*, &c.

The fine long threads in brooch-stones, known as "Venus'-hair" are usually fibres of Asbestos or long acicular crystals of Titanium embedded in pure crystalline quartz. The "Venus'-hair" sometimes also consists of Actinolite or Tremolite, but that in the brooch-stone forwarded to us we believe to be Rutile (Titanium). Professor Tennant has in his collection a magnificent mass of pure quartz containing wire-like crystals of Titanium more than two inches in length.

TERTIARY STRATA WEST OF WOOLWICH, AT PECKHAM, &c.—After reading in the July number of THE GEOLOGIST the description of that interesting section of the Tertiary strata exposed at Woolwich, many doubtless like myself visited that locality and returned gratified. On thinking that it might be possible to trace that series inland or westwards, I concluded to try, and what little success I have met with may perhaps not be uninteresting to some of your readers. After leaving Woolwich in that direction, the first traces of the shell-bed which I found were in the cuttings of the London, Brighton, and South-

Coast Railway, near Brockley Lane, where earth has been thrown up, and in it are portions of shell-marl, containing *Cerithium*, *Cyrena*, with a few *Paludinæ*, and oysters. It is difficult to obtain good specimens there, most being crushed, owing to exposure to the weather.* Proceeding now in a north-westerly direction over Telegraph Hill to within about a hundred and fifty yards south of St. Mary's-church, Peckham, there is a small stream cutting through a shell-bed, met with there *in situ*, five feet six inches below the surface. Overlying is a band of pebbles about three inches in thickness, and above this a mass of gravel and clay containing septaria and angular-flints. The marl here is so destroyed by the action of running water as to render it almost impossible to distinguish the species of the shells it contains; but in an adjoining field, where excavations have been made for different purposes, the marl has been thrown up, so that with a little care and patience some tolerable specimens of *Cerithium*, *Cyrena*, and *Paludina* can be obtained from the pieces scattered about. In passing down the road towards the church we find on the left a pathway across the fields, and after following it for a quarter of a mile, we come to a field on the west side of the "Braid" and there find crushed shells of *Ostræa*, *Cyrena*, &c., scattered on the surface. Passing on to Cow-lane we discover near a stream running for some distance by the side of the road a capital section, showing distinctly the positions of the different strata:—1st—a layer of oyster-shells of about two inches; 2nd—hard, compact shell-marl composed, of *Cyrena*, and *Cerithium*, one foot three inches; 3rd—blue clay containing casts of *Paludina*, many of which when broken present a very beautiful appearance, closely resembling the crystallization sometimes occurring in the cavities of flints, one foot; 4th—gravel with rounded pebbles, one foot six inches; 5th—a mass of clay four feet in thickness, containing septaria and a few flints.

Now the oyster-bed (1) is evidently a continuation of that which occurs at Woolwich, though considerably thinned out. The shell-marl (2) also seems identical with that numbered 7 in the Rev. Mr. Bonney's description; but the next (3) is decidedly a new bed not seen at Woolwich, although it is found at the church- and railway-cuttings, a few inches in thickness. The pebble-bed (4) seems contemporaneous with No. 4 in the Woolwich section, but appears destitute of fossils.

It is interesting to mark the gradual diminution of the salt and brackish mollusca, and the introduction of fresh-water shells. The shell-marl (2) which is about fourteen feet thick at Woolwich here only reaches one foot three inches, thinning out in its westward course; while the overlying stratum, here twelve inches, gradually diminishes eastwardly, until at Woolwich we find no traces of it, although the pebble-bed there (6) may be of the same period, as I have found in it some small Paludinæ, which probably were washed down and killed by the salt-water.

We may conclude that the ocean once covered the site of the present oyster-bed at the mouth of a large river which seemingly followed nearly the same course as the Thames at the present time.

The salt-water gradually receding or becoming brackish from the increase of fresh-water deposited the overlying stratum, which naturally diminished in thickness on the land-side, from the predominance inland of the river-water. Still continuing to increase in volume, the next deposit of blue mud or clay was formed containing the paludinæ, so characteristic of its fresh-water conditions. This bed thins out, as we should have expected, in an opposite direction. The old river still continuing to bring down mud and clay from the country which it drained again formed the deposits immediately above. During the same period at Woolwich a much more varied series of deposits was going on; advances and recessions of the sea causing the pebble-beds (containing shells, mostly waterworn, having been washed from inland) and bands of different coloured sands with shells, some of which having their valves closed show these sands to have been their former habitat. In the pebble-bed (4) I have found many shells of Cyrena, perforated by boring-mollusks—such as the Buccinum and Purpura; and after searching for some time I was rewarded by finding a few Buccina, not at all waterworn, in fact very perfect, proving that they also had died where they are now found, their remains lying buried beside those of their victims. These shells also show the preponderance of salt-water during the formation of this deposit.

---

* At Erith and some other places the shells, as found *in situ* in the marl, are much crushed and broken.—Ed. Geol.

Land about Peckham now being in request for building-purposes, we shall not long have an opportunity of examining the strata in that locality.—Edmund Jones, Islington.

Mineral Manure in the Greensand.—Sir,—Having now, for the first time, come in possession of The Geologist, and finding it to be a first-rate journal for intelligence both for the tyro and the professor of this noble science, I beg leave to ask the following query. I have lately either heard or seen in print that the Rev. P. B. Brodie, F.G.S., of Rowington, near Warwick, had discovered a manure in the green-sand formation which underlies the chalk, that, if I recollect correctly the statement, had fertilizing properties equal to coprolites. If this be in any way true, I should feel extremely obliged if this intelligent reverend gentleman would communicate to The Geologist the way in which it was detected, and the means whereby it may be procured with pecuniary advantage to agriculture?—Yours faithfully, Robert Mortimer, Fimber.—There exists, both in the Lower Greensand and the Upper Greensand, very generally throughout both England and France, considerable beds of nodules of phosphate of lime, perfectly fit for the manufacture of superphosphate, &c., for agricultural purposes. These beds have been well known to geologists for many years, and have been frequently pointed out in the vicinity of Boulogne, of Havre, of Folkestone, of Farnham, in various parts of Sussex, in the Isle of Wight, and Dorsetshire, &c., by Mr. J. C. Nesbit, Professor Morris, the late Dr. Buckland, and myself. Dr. Fitton also noted their occurrence at Folkestone as far back as 1836. In Cambridgeshire those of the Upper Greensand have long been profitably and extensively worked for agricultural purposes. Wherever the Lower Chalk, Gault, and Greensand exist, these beds have only to be looked for to be found in greater or less force.

Beds of phosphatic nodules also occur in the Kimmeridge-clay, as well as in other deposits.

We are not aware of the particular instance pointed out by Mr. Brodie, but doubtless that gentleman, an early and respected correspondent of our journal, will respond to Mr. Mortimer's question in our pages.

The nodules from the Gault, as also those from the Lower Greensand at Folkestone contain from 40 to 45 per cent. of phosphate. Those of the Upper Greensand of that place are very excellent in quality, but small in size; the vein also is very thin, and consequently not profitable for working. The stratum of nodules at the junction of the Gault and Lower Greensand is there from eight inches to twenty inches thick, but rather sandy.—Ed. Geol.

The Palæontographical Society.—Dear Sir,—Has the Palæontographical Society broken up? I see no mention of them in "Kent's Literary Year-Book." Who publishes or has published their monographs; and what is the cost of them?—Yours truly, G. Fowler, Derby.—The Palæontographical Society is, we are happy to say, not defunct, but if rumour may be trusted, its temporary obscurity is caused by the politeness of Dr. Bowerbank in waiting for Professor Owen. It would however, we think, be far better both for the interests of the Society and the satisfaction of its members if the Society's publications were punctually delivered, whether thick or thin, at their appointed times; to publish, in fact, what *was* ready, instead of waiting indefinitely for that which *ought* to be so. We have had many inquiries of the like nature, which, from a desire of non-interference with any society's individual management and conduct, we have not hitherto noticed. The monographs are delivered to the subscribers only, and are not published. The subscription is one guinea per annum; and subscribers can substitute any of the printed monographs for that due for the current year of their subscription, or they can subscribe for any or the whole of the past years.

LONDON CLAY FOSSILS.—DEAR SIR,—Can you inform me of the best locality for obtaining London Clay fossils, having been disappointed in my excursions to Highgate and Hornsey? I also find it difficult to purchase them. —Yours truly, EDMUND JONES.—Fossils are, we know, difficult to be got by the uninitiated at Highgate and Hornsey. They occur chiefly low down in the beds; and the few accessible localities require to be pointed out by some one conversant with the pits. At Highgate they should be sought for at the base of the bank near the Archway. We should be obliged to any of our readers and correspondents to send us notes, at all times, of any excavations or pit-sinkings, which may come under their notice, where London Clay fossils may be got.

CONTEMPORANEITY OF ROCK-FORMATIONS.—SIR,—Are the formative processes of the several geological systems which flank the primary upheavals in different parts of the world considered to be simultaneous? For instance, when the carboniferous deposits were going on in the British isles, was the same system of deposits in operation in other regions of the globe, where we find it developed?—I am, Sir, yours truly, JOHN CURRY, Boltsham, near Darlington.—With certain reservations our answer would be generally in the affirmative. It has, however, been observed that the present Australian life is like that of the ancient Jurassic, that is, geologically the equivalent of the oolitic age, although contemporaneous with the actual phase of the Tertiary period in which we exist. In like manner there appears to have been a certain variation and relation of organic forms between the ancient Triassic and Jurassic formations all over the world—local oscillations, so to express it, of the geographical distribution of at least resembling forms between the Triassic of the one age and the Jurassic of another, but both at particular periods existing contemporaneously in different parts of the globe.

NON-PROTRUSION OF SOLID GRANITE.—SIR,—I wish to ask for some information on the following subject. Some time ago I heard a lecturer on geology, whose name I will not mention, but who is well known as a gentleman of great reputation in the scientific world, assert "that in no instance had granite ever been protruded right through superincumbent strata, although it may have heaved and dislocated them to a considerable degree." Some surprise being shown by certain of the audience at this assertion, he accounted for the subsequent exposure of the granite by the disintegration of the incumbent strata by atmospheric and other abrading influences; in other words, he stated that *all* the numerous granitic peaks, which we now see rising far above the natural surface of the earth, had cooled at enormous depths beneath it.

Now, Sir, I wish to ask if any instances have been found of granite in large masses—for we must not confound them with veins of the same rock—*overlying* sedimentary deposits, giving the appearance of their having overflowed at the time of upheaval? If such occur, I would again ask how you could reconcile such facts with the supposition above-mentioned, viz., that granite has never protruded through strata, and consequently could never have overflowed? If no instances of granite lying upon aqueous rocks have been observed, I do not see why the theory of the "non-protusion" (if I may so call it) of granite should not be regarded as very plausible; but if, on the other hand, instances have been discovered, then I should think the idea must fall to the ground, unless the facts can be accounted for in any other reasonable manner.

I am but a young geologist, and therefore not thoroughly versed in all the details and intricacies of this most interesting science; but this is a subject upon which I should be very glad to obtain some information—Yours, &c., EDMUND ST. AUBYN.—Granite has always been regarded by modern geologists as a crystalline rock formed under great pressure in the depths of the earth. Mr. Sorby has written some excellent papers on the evidence of the presence of heated water in the changes effecting the transmutation into granite; and in the elementary works of Sir Charles Lyell and others, diagrams are given illustrative of the manner of the metamorphosing action, which display also how the lowermost or deepest granite must be the most recently formed.

No evidence whatever, so far as we know, exists of the over-run or out-flow of granite like a lava-stream. Such effluxes of volcanic matter are found in the form of bedded trap-rock, basalt, &c., all of which have been ejected from an orifice or chimney of eruption. Not so granite, which is boss-like and, probably even, only ordinary sedimentary rock changed or altered by the uprise of the range of the isothermal lines of the internal heat consequent on the stopping out, by the deposition in the ancient ocean-basins of thick masses of sediment, of the conductive action of the ocean-water on the principle pointed out in the article on "Common Fossils," at page 154 of the present volume of this Magazine.

The action of heated water combined with pressure is accounted for in the consequent heating, under such circumstances, of the infiltered water always met with at great depths. The principal evidence brought forward by Mr. Sorby on this point is the presence in granite-rock of small cavities partly filled with water, the explanation of which is, that being originally bubbles of hot water or steam, as the cooling of the granite took place, these contracted in dimensions, leaving the cavities only partly filled with globules of the condensed fluid.

The continued heating and expansion of the lowermost rock-masses or other causes and actions may have caused a protrusion of the upper and solidified portion of a granite-mass, in some rare or doubtful cases, but such a fact would in no way militate against the general doctrine of the graduality and profundity of the granitizing operations.

FORMATION OF MINERAL VEINS BY SIMPLE SEDIMENTARY DEPOSIT.—SIR, —The excellent paper on the deposition of strata in your April number, showing how unnecessary it is to refer to any other cause than the natural shoal formations, the different complicated appearances of horizontal and perpendicular strata leads me to ask if mineral-veins have not had the same origin? I mean, have they not been laid down in fine seams perhaps on sloping shoals ere they or the beds containing them were fused and crystallized by volcanic agency? From whatever source the minerals themselves were derived—and we know that silver, copper, &c., are finely diffused in the sea—there is nothing improbable in the idea that they may have been strewed over a muddy or sandy shore, as the case may be; and no one can walk along a rock interstratified with quartz, &c., without coming to the conclusion that *it* in this way came into its present position. The ores and various metals they contain appear to me to have been alike deposited in thin layers at intervals amongst the other *débris*.

May I also trouble you to tell me what you consider the best authority to consult upon Infusoria? Also on the formation of fossils, as I believe the circumstances under which the latter were produced must have been extremely rare: for instance, had the shoal of Sand-launces mentioned by Dr. Dawson died in coral-mud impregnated with silicic acid, would they have been preserved?—Yours, A., Land's End.—Mineral-veins cannot, in the sense the question is put by our correspondent, be said to be due to sedimentary deposits. In some cases they present the appearance of stratification, as in those instances of filled-up cavernous hollows noticed and described in the papers by Dr. Watson, in vols. i. and ii. of this magazine. Mr. Salmon's articles on ore-veins, commenced in our last number, will also give our correspondents much information on this topic.

Certain bands of ironstone-nodules are interstratified in the sedimentary beds of the Inferior Oolite and of the Lias. The Lower Greensand of the Cretaceous group, and the "basement-bed" of the London Clay amongst the Tertiary rocks offer instances of sedimentary strata being so highly impregnated with mineral matter as to be sometimes equivalent in metallic richness to the mineral-veins. The ironstone-nodules and strata of the Wealds of Kent and Sussex were in Roman and mediæval times largely worked as ores, but mineral-veins proper cannot be regarded as contemporaneous formations with the strata in which they occur.

Ehrenberg is the great authority on Infusoria. A very nice condensed account of this class was published some years since by Mr. Pritchard, the optician and microscopist, and a new edition has been more lately produced. Dr. Mantell has given an account of some British species in a very interesting little volume. The "Micrographical Dictionary" gives a vast amount of information about Infusoria; and there is a good article on the subject in the "Cyclopædia of Anatomy and Physiology."

It is not in every case, as rightly suggested, that organic objects are preserved; the circumstances attendant on their fossilization must of course be exceptional.

Fossils of the Red Chalk.—I am able to add one species to the Vertebrata in the list of fossils given by Mr. Wiltshire in his interesting paper on the "Red Chalk." I found a tooth of a species of Notidanus in the Red Chalk of Speeton, when I visited that place in 1854.—Rev. T. G. Bonney, M.A., Westminster.

REVIEW.

Esquisse Géologique et Paléontologique des Couches Crétacées du Limbourg et plus spécialement de la Craie Tuffeau. By Jonkhr. J. T. B. van den Binkhorst. Part I. 8vo., pp. 268. Five Plates and a Geological Map. 1859. Maestricht.

Limburg, a south-easterly province of the Netherlands, bounded by Prussia and the provinces of Liege and North and South Brabant, has been rendered accessible by the iron-roads of France and Germany to thousands of travellers and tourists. Many of these, occupied with their business or their pleasures, care but little perhaps for Limburg and its geological conditions: they might notice as they passed rapidly along that the country was for the most part level and sometimes marshy, and they might probably comment on its general productiveness or the luxuriance of its pasturage, but they might never care to inquire if it had any iron-mines or coal-mines, nor take the trouble to ask any questions about its stone-quarries.

Perhaps the last, however, might be forced upon their notice when they arrived at the capital of the province, for *les grandes carrières de Maastricht* are too vast and too famous to escape the attention of sight-seers.

The fortress on St. Peter's Mount towers high above the sinuous walls and forts of the strong bulwarks which defend the ancient town, while in the hill below it are cavernous passages of such intricate and dark extent that the wanderer into them needs the guiding thread of Ariadne to insure his return to the light of day.

To the geologist this mountain and its quarries have a higher interest than the wonderment they excite as mere gigantic excavations: the strata of which they are composed are the last formed of a great geological age before another vast geological period began—they are the termination of the secondary epoch, the *Moyen-age*, so to call it, of geological history. They are the last-formed patches of the old cretaceous sea before the dawn of recent forms of life commenced with the earliest Tertiary beds.

The soil of the Duchy of Limburg covers rocks of older and of younger age, from the carboniferous to the quaternary; but the chief purpose of the work under notice is to minutely detail those upper cretaceous beds—the chalk of Maestricht—where the chief geological interest centres, and which have for many years attracted general attention, but which only a resident could work out in their minutiæ, and so give to science the exact limitations of the members of its remarkable fauna to the special zones or beds to which they are restricted, or which they serve to characterize, or to link with other cretaceous deposits in other parts of the globe. Already a catalogue of eight hundred species of fossils has been noted down, and the superposition of the deposits tolerably well made out.

To the scientific importance of these quarries but few could refrain from adding some words upon their historical associations and their antiquity. M. Faujas St. Fond, in his history of this mountain, prefaced his geological investigations with such an account, and Herr Binkhorst has made a like digression.

Associated with the changing fortunes and vicissitudes of the successive generations that have resided on its soil from Roman days—perhaps days even more remote—unto our own, what wonder that to an inhabitant the legends of these gloomy caves should have an irresistible attraction. When were they first wrought out? Who were their first excavators? Man cannot answer, and history is silent.

When persecutions with pagan fury were carried on against christianity and civilization, religion, violently banished from the light of day, found an asylum in these catacombs of the north, and the ministers of God, protected by the secrecy and devotion of the Limbourgese, celebrated their divine services surrounded by their enemies.

We pass by too the brigandages in the 16th and 17th centuries, when Bohemian banditti revelled inassailable in these subterranean recesses; and we leave untold scenes and incidents which have happened in these caverns "vast and gloomy" during the many seiges Maestricht has had to sustain; we forbear to tell the kind or sinister offices of gnomes or fairies with which superstition and fancy have peopled these obscure places; we tell not the stories of all the gaunt skeletons of man, woman, or child who, lost in their wanderings, have perished there of want; nor do we detail the oft-told torch-light combat of the Austrians and French in these darksome passages during the siege of 1794.

All these anecdotes and more our author repeats; and in his introductory episode, as well as throughout the work, he appears to have gleaned materials from every available source. In this respect, in the geological portion of this part of his book, our author has shown extreme industry; and had the arrangement of the matter thus collected been more methodical, the reader would have derived still more advantage from this valuable accumulation of selections, which is saved from approaching the character of a mere compilation by the amount of local knowledge with which it has been intercommingled.

The authorities for the information thus amalgamated with the original matter are for the most part duly acknowledged and referred to in the text or in foot-notes. We should, however, have liked to have seen the labours of the Commission for the Geological Survey of the Netherlands more prominently brought forward by the author, especially in respect to the geology and palæontology of the Limburg region. M. Bosquet's elaborate memoirs on the cretaceous Crustacea and Brachiopoda of Limburg appear to have escaped recognition in this way, although the results of M. Bosquet's labours are embodied in the work. The following are the deposits described in this first part:—

A—Quaternary: the Loess or Lehm, with its remains of *Elephas primigenius*, Rhinoceros, &c., and the flint weapons of primæval men (p. 2); 2, gravels and erratic boulders (p. 7). B—Tertiary: 1, Bolderian-beds (p. 12); 2, Rupelian-beds (p. 15); 3, Tongrian-beds (p. 17). C—Under the head "Cretaceous" we have accounts of the 1, Craie Tuffeau (p. 25), illustrated by the details of a section taken near Fauquemont; 2, Craie de Schaasberg (p. 52); 3, Marne de Kunraad; 4, Marnes de Simpelveld and Vetchau (p. 64); 5, Craie siliceuse de Kunraad, Benzenraad, et Simpelveld (p. 71); 6, the strata near Jauche in Belgium (p. 79); 7, those at Jondrain (p. 83); 8, those at Ciply (p. 85); 9, Sand-pipes and channels (98); 10, *Résumé,* (p. 108); 11, Craie blanche à silex noirs et marnes sans silex (p. 136); 12, Sables vert à *Belemnitella quadrata* (p. 161); 13, Couche de cailloux roulés et sable d'Aix-la-Chapelle (p. 181). D—The Coal-formation (p. 185).

As we have said before, the author's industry has accumulated a mass of valuable facts relating to the deposits above enumerated, while his knowledge of the localities and his method of carefully collecting the fossils have given additional value to his remarks. Some of his catalogues of fossils appear to be enriched by the local lists of Bosquet and others; and we must judge of them in accordance with his own modest statement of his palæontological acquirements. In the résumé at page 108, in the general considerations at page 220, in the preface, and in the notes at pages 231-267, the reader will find many interesting observations and extracts illustrating various topics discussed in the book.

In Plate III. of the illustrations, and at p. 29 of the work, the section of the Cretaceous rocks surmounted by Tertiary deposits at Heunsberg, near Fauquemont, is given, presenting to view the strata in the following succession:—

	Metres.
1. Vegetable earth	1·00
2. Loess	1·00
3. Rolled pebbles	3·00
4. Quartzose ochreous sand, of a yellow colour, with streaks of strong red	10·00
5. *Craie tuffeau*	1·50
6. A stratum very rich in fossils, chiefly *Hemiaster prunella, Rhyncolithus Buchii, Rh. Debeyi*	0·60
7. *Craie tuffeau*	1·00

This bed is stated to attain a thickness of twelve metres at Geulhem, half a league from Fauquemont, where the fossils are commonly presented in the form of casts, and Herr Binkhorst notices in it an Ammonite which resembles *A. pedernalis*, Roem., but which he considers a new species, and as probably being the last of those cephalopods.

		Metres.
8.	Bed of Bryozoa	0·20 to 0·80
9.	Hardened rock, encrusted by serpulæ, bryozoa, and oysters	0·60 to 0·70
10.	*Craie tuffeau*, formerly worked at Bemelen and Geulhem as a building-stone	6·00
11.	Extremely hard and compact rock, containing numerous organic remains, amongst which are *Belemnitella mucronata, Dentalium Mosæ, Arca, Spondylus, &c.*	0·30 to 0·40
12.	Second bed of Bryozoa	1·00
13.	Stratum of very hard rock, inclosing a great number of lenticular concretions covered with cellepores, bryozoa, and serpulæ	0·50 to 1·00
14.	*Craie tuffeau*, with fossils *Hemipneustes radiatus, Mesostylus Faujasii, &c.*	12·00
15.	Stratum containing a second bank of oysters, nearly entirely composed of *Gryphæa vesicularis*	0·50

Herr Binkhorst notices as found in this bed teeth and other remains of *Mosasaurus Camperi*, and of species of *Corax, Otodus, Enchodus, Lamna, Sphærodus*, and *Pycnodus*, with portions of the carapace of the great marine turtle, *Chelone Hoffmanni*.

16.	Stratum of hard rock, containing but few fossils	0·30
17.	*Craie tuffeau*, fossils rare	0·04
18.	Stratum containing many peculiar Bryozoa and other fossils, with remains of *Mosasaurus* and of *Chelone Hoffmanni*	0·22
19.	*Craie tuffeau* containing nodules of flint	1·00
20.	Stratum of very hard and compact rock containing numerous Gasteropods; and often very perfect imprints; casts of a small Turritella *(T. socialis)* are extremely abundant, with those of *Nucula ovata* (Nilson) and *Dentalium sexcarinatum*	0·30

Remains of cretaceous plants and trees are also met with in this bed.

21. *Craie tuffeau* with beds of flint-nodules.

It is not within our present limits to follow Herr Binkhorst minutely through the details of the strata of his province, nor to notice those other portions of this part of his book which treat of the Coal-measures and Tertiary deposits of his duchy, although these too are highly interesting, the one having been illustrated by the admirable labours of Professor de Koninck, the other by the equally valuable productions of M. Nyst and Sir Charles Lyell. With these and other topics we may deal when the author presents us with a second portion, considering it sufficient at present to draw attention to a work which, if not so complete as we could wish, must still prove, through the full account it furnishes of those singular cretaceous deposits so rich in fossil organic remains, of very considerable service to all geologists visiting the interesting district of Maestricht.

THE GEOLOGIST.

NOVEMBER, 1859.

THE COMMON FOSSILS OF THE BRITISH ROCKS.

By S. J. Mackie, F.G.S., F.S.A.

(Continued from page 388.)

Chap. 6.—*First Traces of the Succession of Life.—The Lower Silurian Rocks.*

As one carried beyond his depth for the first time into the waters of ocean, and struggling shorewards, touches but now and then the yellow sands, with every heaving wave again to be set afloat, feels a delight when he plants his foot solidly on the sands, and wades through shallower water to the shore, so do we after our almost footless path through the wide waste of water of the first age, hail with delight our firmer footing on the spreading shores of this next great geological period.

The first argument of the antiquity of the globe is drawn from the successive accumulations of strata inclosing different creations of organic beings, which form the stratified portion of the earth's crust.

The next argument of length of time is taken from the evidence which the remains of those ancient organic beings afford of the long periods of their existence on the face of our earth. It is not the strange obscure forms of three-lobed legless crustaceans, revealed to us by such distorted and crumpled fragments that the eye is strained in the effort to make out the details of their shapes, that astonishes us so much as the familiar look of the little shell-fish we meet in these old Silurian rocks.

From the humblest cottage to the stateliest mansion the beautiful shells of ocean depths are treasured ornaments; and, unless it be flowers, few things, if any, as a class are more beautiful. Pearly in structure, exquisitely marked and colour-painted, often elegant in form, they are worthy natural ornaments to be prized and treasured; whether some son, brother, father has brought them after long voyages from distant parts, or some child had picked them off the neighbouring strand.

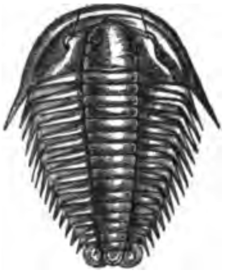
So common and so homely are our associations with shells that the first trace of them in the stony strata of our earth strikes us with more than usual interest. Somehow, one seems to regard them as old acquaintances, as something familiar and not strange, as something that brings back our childish feelings to our scathed and hardened hearts, and makes us for the moment gentler than in the stern fight of life we are wont to be.

Lign. 6.—Lingula Davisii (nat. size). From the figure in the "Synopsis of British Palæozoic Fossils," by Sedgwick and McCoy. Plate i., L, fig. 7. From a specimen from slates south of Penmorfa.

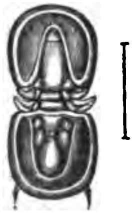
Yet in those first fossil shells we recognize the mollusc-type. Shells very like them, very like indeed, still exist, but deep down in the sea and afar off. One very rarely sees any, and then only in the cabinets of the curious, for they are small simple dark horny shells and not attractive, and the antique fossils, crumpled and distorted as they mostly are, in their glistening blackness outvie their modern dusky representatives. Wonderful indeed are the varieties of markings and forms of the two simple valves inclosing the symmetrical mollusca. A pair of shells held together and pressed open at one and the same time by a tenaceous, elastic ligament, would scarcely, one would have imagined, have afforded much room for diversity of structure or shape; but thousands of distinct and living species have been examined, and recorded by naturalists. Every ship returning from new and distant parts is daily adding to the extensive catalogue, while the fossil species are not inferior in number to the recent. But it is not in mere outline or shape alone their characters are varied: chiselled, ribbed, striated, and cancellated with every kind and description of line, groove, and ridge, their markings are only exceeded in their diversity by the infinity of the vivid hues and curious designs of their beautiful paintings.

The pearly lustre and nacreous prismatic tints may have vanished from the remains of those soft-bodied inhabitants of the fossil shells, but the beauty of their forms and the delicacy of their markings are truly preserved by Nature's unerring hand in the crystalline marble into which their shells in the lapse of ages have been turned. Sunk into pits, or attached to protuberances, smooth, or interlocking, even that most primitive of all attachments, the ligamental hinge, is never alike in two species, is never repeated, as though infinite change was part of the great scheme of creation, an attribute of the Deity, to be manifested alike in pleasure or pain, in the world or the universe, and in the grandest, or most trivial and simple of things.

The Lingulæ of North Wales were first discovered by Mr. Davis, in 1845, near Tremadoc, and in the same Lower Silurian beds are associated the remains of several species of trilobites, namely, *Olenus micrurus*, *Agnostus pisiformis*, and a Paradoxides, supposed by

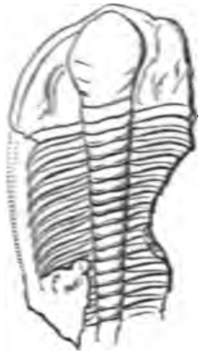


Lign. 7.—Olenus Micrurus (nat. size). From the figure in the "Decades of the Geological Survey," No. ii., plate ix. From a specimen from Trawsfynydd, Merionethshire.



Lign. 8.—Agnostus pisiformis. From Angelin's "Palæontologia Suecica," pt. i., 1852, tab. vi., fig. 7. [Syn.: Entomolithus paradoxus var. pisiformis. Linnæus Iter. Scan., p. 122. Syst. Nat., ed. xvi., vol. iii., p. 160.]

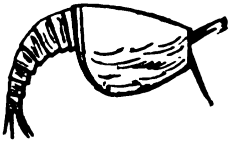
Mr. Salter to be identical with the *Paradoxides Forchhammeri* of Angelin from the alum-shales of Andrarum, in Scania.



Lign. 9. — PARADOXIDES FORCHHAMMERI (? Angelin) from the figure in "Siluria" of the specimen in the Museum of Economic Geology, Jermyn-street.

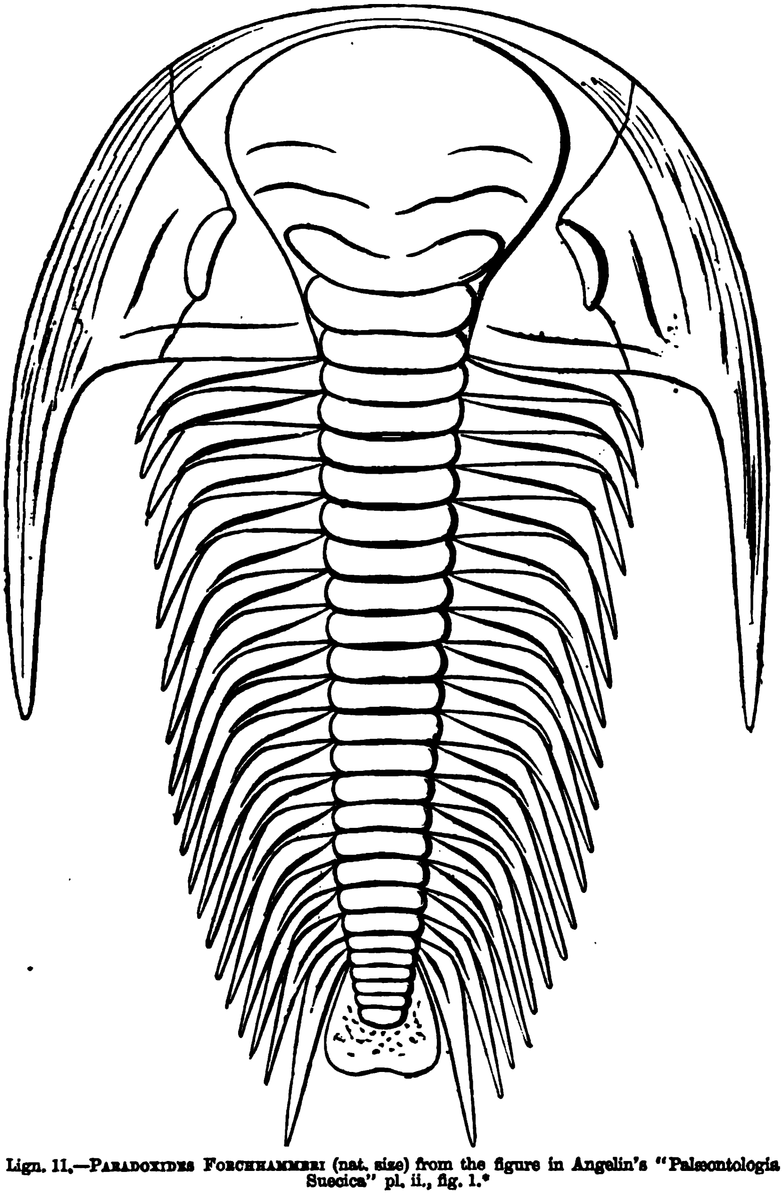
Although but little known in the English strata, these little Agnosti are, according to Brongniart, so abundant in the beds near Heltris, in Sweden, as to give an oolitic character to the rock.

Remains of a phyllopod or stomapod crustacean, *Hymenocaris vermicauda*, occur plentifully in the beds with *Lingula Davisii* at Dolgelly and Tremadoc, where so-called tracks of annelides, sometimes of considerable size, are also stated to be met with.



Lign. 10.—HYMENOCARIS VERMICAUDA. From the restored figure by Mr. Salter in "Siluria." From specimens from Dolgelly.

Some caution may be necessary in speaking of such fossils as worm-tracks; for although no remains of Olenidæ have as yet been found in these "track-mark" beds, yet as those trilobites are found in strata of equivalent age, it is quite possible that they existed on these shores when these Silurian sediments were formed. And as Mr. A. Hancock has shown in his valuable paper on Vermiform-fossils, in the "Annals of Natural History" for 1858 (3rd series, vol. ii, p. 443), that some of the so-called annelide-tracks have been formed by small burrowing crustaceans, it is quite possible that we



Lign. 11.—PARADOXIDES FORCHHAMMERI (nat. size) from the figure in Angelin's "Palæontologia Suecica" pl. ii., fig. 1.*

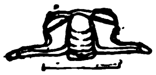
---

* "Paradoxides Forchhammeri (Angelin) n. sp., P. fronte sulcis 4; anterioribus 2 medio obliteratis; abdomine spathulato, mutico. Loc. Nat.—.In stratis calcareis regionis (B.), *Scaniæ* ad Andrarum."—Palæontologia Suecica, pars. i., fasc. i., 1852."

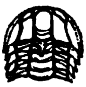
have in these ancient markings the traces of the burrowed channels of Olenidæ, or other small crustaceans.

Tracks similar to those made by shrimps are found on some of these Lingula-slabs, and have been ascribed by Mr. Salter to the Hymenocaris.

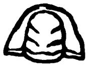
In beds of the same age, near Bangor, two species of fucoids, *Chondrites acutangulus* and *Cruziana semiplicata* are recorded; while in the black schists on the western flanks of the Malvern Hills three other species of Olenus, *O. bisulcatus* (Phillips), *O. humilis* (Phillips), *O. scarabæoides* (? of Wahlenberg) are met with.



Lign. 12.—Olenus bisulcatus.

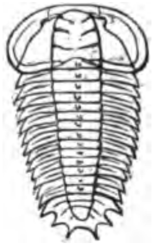


Lign. 13.—O. humilis.



Lign. 14.—O. scarabæoides.

From the figures in "Siluria," from fragments of specimens from Malvern.



Lign. 14. — Olenus scarabæoides (of Wahlenberg). Nat. size. From the figure in Angelin's "Palæontologia Suecica."*

---

* Olenus (Peltura) scarabæoides, Wahl. nat. size. Angelin, p. 45.

"Loc. Nat.—In stratis regionis A, *Vestrogothiæ* ex. gr. ad Kaflas, Klefra, Carlsfors; *Nericiæ* ad Latorp; *Œlandiæ* ad Algutsrum; *Scaniæ* ad Andrarum. In *Norvegia* ad Opslo.

"*Corpus* angustum, ovato-oblongum distincte longitudinaliter trilobum; crusta lævis vel aciculata.

"*Caput* breve, subreniforme, valde convexum, undique marginatum sulcoque intramarginali præditum; anguli exteriores rotundati, mutici.

"*Oculi* minuti, papillæformes—distincte reticulati loboque orbitali parvo instructi, valde approximati, apicales. Sutura facialis portice ab oculis ad marginem baseos anticeque ad marginem apicalem ducta.

"*Frons* distincta, lata, ovata, valde convexa, obsolete lobata, marginem apicalem subattingens. Costa facialis utrinque, obsoleta, brevissima, inter apicem frontis lobumque orbitatem ducta.

"*Thorax* segmentis 12 longitudinaliter sulcatis, apice acutis; rachis distincta, convexa, pleuris latior.

"*Abdomen* parvum, immarginatum, margine dentatum, costis lateralibus obsoletis; rachisbrevis, crassa, conica, marginem haud attingens."—Angelin, pars. i., fasc. ii., 1849."

With these Oleni there also occurs the *Agnostus pisiformis*, a fossil which we have already noticed in the Welsh beds, and as characterizing the oldest Silurian schists and alum-slates of Sweden.

We have also at Whitesand Bay, in South Wales, the Cambrian strata, overlaid by beds of flagstone containing the characteristic *Lingula Davisii*; and we ought not to omit to mention that the white crystalline and fissured rock at Grantham, near Pontesford, in Shropshire, is penetrated by a vein of anthracite, small flakes of which are also disseminated through the mass.

It is difficult at present to account for the occurrence of this substance so commonly regarded in more recent deposits as of terrestrial vegetable origin. This ancient anthracite may, however, have been derived from sea-weeds, or indeed from land-plants, although no remains of such have as yet been found in these lower rocks; or, on the other hand, its origin may have been due to accumulations of animal matter.

GENERAL CONSIDERATIONS ON THE FORMATION OF ORE-VEINS.

(*Translated from the German of* PROFESSOR BERNHARD COTTA, of Freiberg, *with an Introductory Notice on the Study of Mineral Veins and Metalliferous Deposits, by* H. C. SALMON, ESQ., Plymouth.)

(*Continued from page* 396).

VIII. *Texture of Ore-Veins.*—The varying texture of ore-veins referred to towards the end of Prof. Cotta's memoir may not be intelligible without a short explanation. We find that the two extreme textures of veins may be classed as (1) a *compact* texture, and (2) a *banded* or *layer-like* texture, both of these of course having many varieties, and passing into each other. The first is often characterized by a *breccia*-texture, that is by containing fragments—often very numerous—of the neighbouring rock. The figure below shows an ex-also have occurred, entirely altering the dissolving and precipitating power of the circulating fluid, and consequently giving us, in the newer fissures, a set of minerals, which although they *existed* in circulation in the older fissures, could not be precipitated in consequence of the higher temperature then existing keeping them in solution; while, similarly, the newer fissures could not contain many of the minerals found in the older ones, inasmuch as the temperature had now so fallen as to render the circulating fluid incapable of holding them in solution.

3. *The analogies found to exist between* the relative age and general characteristics of *veins in countries widely apart*, which gave rise to the theory of "formations," are accounted for by assuming them to be the "everywhere tolerably analogous consequences of local eruption, which may have been very far separated from each other by time." The supposed synchronous "formations" merely "representing the same stadium of local activity," each stadium being assumed to produce results tolerably analogous, however widely removed in time and distance each isolated process may have occurred.

4. Cotta also finds in the *the structure of the Freiberg veins* a proof of the general truth of his hypothesis. The older veins he finds to be generally massive, while the newer have a banded, or layer-like form; these structures, in both cases, being such as might *à priori* have been expected.

5. With regard to the *infiltrative origin of veins*, it is admitted to be possible, although not probable, for *all* ore-veins; as to the newer and banded veins such an origin seems to be accepted. Tin-ore is considered as not being found in purely infiltrative veins, although circumstances are referred to which seem to indicate that there are cases where that ore cannot have otherwise originated.

X. *General remarks.*—Although this hypothesis affords a general solution of many obscurities, it is not pretended that it is itself without difficulties: the whole question of metalliferous deposits is far too involved with various complicated geological phenomena to be so lightly dealt with. The hypothesis is at best a suggestion for consideration; but it has this advantage, that it embodies in a definite form a set of facts, with which it harmonizes admirably. The greatest objection to this hypothesis is probably that it involves the theory of a cooling globe, and thus places itself in antagonism to the Lyellian doctrines, now rising to popularity. But it seems to me that this antagonism is more apparent than real; and that the hypothesis might be made to harmonise with the Lyellian philosophy accepted in the moderated form in which it is most popular.

The investigations of Sorby and others now lead us to believe that many of the crystalline rocks are hydato-pyrogene rather than purely pyrogene—that is, were formed at a high temperature, but in connection with water. This discovery is of the very highest importance in the theory of ore-veins, for in them we constantly find occurrences which can be only accounted for by the action of water, which in fact seems to have been the carrier from the metallic source, where it took up the ore in solution, conveying it to, and subsequently precipitating it in, the vein.

I have already referred to metalliferous deposits originating by metamorphism, or by replacement and change of constituents, without any original fissure. I am not going to refer to these again here; but I wish to point out that almost every vein-deposit, no matter how found, must have been subject to some such similar metamorphic action, from the very hour of its original filling, tending to modify its contents in a greater or less degree. Never-ceasing change is as much the law in the interior of the earth as at the surface; the changes may be slow, but in Nature nothing is absolutely stationary. Hence it does not follow that the minerals we now find in any vein are in the same state, either as to form, or combination, in which they were originally placed there. Many instances occur where it is most important to bear this in mind.

In following out inquiries into the origin of metalliferous deposits, we must never fail to bear in mind the caution of Prof. Cotta that they are not to be regarded as "an isolated phenomenon." This caution may be un-necessary for geologists; but unfortunately it is not so for "practical" men. No one can usefully approach this subject, with the object of generally investigating it, without a thorough knowledge of the principles of .Geology, an intimate knowledge of rocks, and an accurate acquaintance with mineralogy.

GEOLOGICAL TOPICS.

THE FIRST TRACES OF MAN ON THE EARTH.

"There are stranger things" wrote old Aubrey, "than a man sees in a journey between Staines and Windsor." Doubtless there are, and not the least strange in modern times is the discovery of the works of men's hands in association with the bones of mammoths and other extinct terrestrial beasts, which have always hitherto been supposed to have passed away before the "lord of all he surveys" made his appearance. For years it has been the practice of geologists to ignore any asserted evidence of human remains in the same strata with those of the great extinct mammalia, and certainly, generally speaking, the evidence offered was carelessly got, or only very imperfectly substantiated, so that, in its general weakness and unreliableness there is some justification of the practice. An energetic French antiquary, however, has brought the matter so prominently forward, and substantiated his assertions by discoveries and proofs at once so novel and so convincing, that geologists and antiquaries were both alike compelled to investigate the matter, and neither have hesitated to accept the proofs afforded.

We cannot, therefore, do better than first bring before the reader the labours and opinions of this gentleman before we enter into the consideration of the knowledge acquired since their publication, or review the mass of imperfect materials which had previously been accumulated.

Twelve years have now elapsed since M. Boucher de Perthes, the well-known antiquary of Abbeville, published the first volume of his memoir, "Antiquités Celtiques et Antédiluviennes." on the primitive works of human art, and gave expression to his idea that some of those he had discovered belonged to a geological age. The reception that first portion his book met with at the hands of scientific men, as well as by the public at large, is well expressed in the preface of the part given to the world in 1857. Without doubt the work in question really was, as we are there told, the fruit of long researches and conscientious study, and that all applauded without reserve everything he had shown concerning the Celtic people, not only their arms and their stone-tools, but their household utensils, their instruments of agriculture, &c., of which before him no one had any idea. If these curious discoveries extended the limits of our history, they did not increase the antiquity of man. To these remarks no one raised a single objection. But it was not thus with the antediluvian antiquities; this title alone, which put in doubt the whole system of the recentness of origin of our race to which we cling so tightly, aroused many prejudices and wounded even more than one susceptibility. This part of the book was condemned before it was read. In vain did the author offer proof of flints bearing the traces of human handling, discovered by himself in the diluvium. In vain his book gave pictures of them, and in vain was the vast gallery which the author had built to his house for their exhibition opened to those who wished to see the objects themselves. The great majority of French geologists and antiquaries spoke not the less against the work; and except some of his personal friends no one would verify the facts, giving as the reason that they were impossible.

M. de Perthes, however, did what other great men have done before him, and what others will do again and again after him. He set to work to accumulate fresh material, to acquire more facts to still more clearly prove his case. From days far older than Galileo to those of our own the teachers of new ideas have had to combat with the world for the reception and propagation of truths, and the plaint of the editor of the present volume will be yet again repeated in other words, but similar sense, by many others.

"Unfortunately in the sciences," says M. de Perthes, with veritable truth, "when they have adopted an opinion, good or bad, they do not like to change it. They could not put in doubt the good faith of the author, but they said that he had believed he had seen, and that he had deceived himself as to the nature of the strata; that the banks and ossiferous deposits which he had explored could not be tertiary, nor diluvial; and that the flints were not worked."

These last were grave objections, but the assertion of works of human art in beds of later Tertiary age was such an innovation upon all previous conceptions of the antiquity of the race of man, that it might be well received with caution, if not with disbelief. The objections, however, vanished; the one on an inspection of the places—no one, with the least acquaintance with geology, doubting, after seeing them, their belonging to those erratic and superficial deposits known formerly as diluvium, but now more generally denominated "drift"; the other, the worked character of the discovered stones, was equally confirmed by inspection. At the first glance one saw "hatchets, knives, tools of divers forms, but all proper to their work; signs and figures that could not be the effects of accident, or of a simple chance-blow."

"Then it was pretended that these flints came from the surface, and that they had been fashioned by the workmen, and afterwards introduced into the beds."

This objection fell too at the aspect of the beds, of which the horizontal position allowed the perception of all infiltration, or vertical introduction. Moreover, these worked-stones resembled those of the beds themselves in having their colour; the diversity of shades, more or less yellow, brown, or ferruginous indicated exactly from which bed each came; and this coloration was not merely superficial, but had penetrated the substance of the worked-flints, and formed part of it.

"All this," continues the writer, "was palpable to those who would open their eyes, but these were a very small number; the majority continued to deny that the fact was possible, and were satisfied not to assure themselves of it." One by one, geologists and antiquaries have been induced to visit M. de Perthes' collection at Abbeville, and one by one, astonished at the sight, have solicited to inspect the beds, and have been convinced. Prestwich, Austen, Mylne, members of the Council of the London Geological Society, have visited the French antiquary's museum at Abbeville, have inspected the strata, and have returned home bringing with them flint-objects which they, with their own hands, extracted from the banks of gravel containing mammoth and other mammalian remains, around that town, and from near Amiens. Mr. Flower, one of the party who accompanied those gentlemen, dug out a large and fine flint-instrument from a depth of eighteen inches from the vertical face of the pit, in gravel undisturbed by the workmen's picks. M. Didron, the learned archeologist, and other French *savans* have tardily followed each other in the acknowledgement of this important fact, and M. de Perthes may well exultingly exclaim "la présence d'ouvrages d'hommes dans le diluvium est aujourd'hui un fait avéré"

The association of the primitive works of man with the bones and skeletons of mammoth, hippopotami, hyænas, and others of the great extinct mammalia of the Post-Pleistocene era does seem to be an established fact.

So far so good for M. Boucher de Perthes, but something more requires to be known. For years past geologists of this and other countries, possessed of preconceived notions, have invariably snubbed all statements of the coincidence of works of human art, or of human remains in the various cavern- and other ossiferous deposits. And yet such statements have neither been few nor limited; but, generally, certainly they have been wanting in precision and exactness—they have been without point. In hardly any, if indeed in any, hitherto recorded cases can we feel sure that the observations have been properly made, or the facts properly recorded. No one has displayed more exactitude than M. de Perthes himself, but he is an antiquary and not a geologist, and it is the geological aspect of the question that we regard; and without disputing the premises that man existed among the mammoths, we still ask how long then has man been upon the earth, and how far back in geological history does his creation date? If it be as facts seem, even yet, although we pre-date his first appearance by some thousands, if not even millions of years, to indicate that man is still the most recent of the divine constructions, we do not materially alter the conditions of previous belief, but only modify it; and no theological considerations can impede our conversion to the new doctrine, as I think it would be hard to find any true biblical grounds for its obstruction.

We are bound, moreover, to look facts full in the face, and to meet all new opinions with careful investigation and scrutiny.

Let us then proceed in our review of M. de Perthes' book; and in gathering our first facts from him, and in making ourselves acquainted with his opinions, we shall be rendering honour where honour is due, and be basing our superstructure on its proper foundations.

BRITISH ASSOCIATION MEETING.

(Continued from page 404).

ON THE OSSIFEROUS FISSURES AT ORESTON, NEAR PLYMOUTH. BY W. PENGELLY, F.G.S. *(Read before the Geological Section of the British Association, on Friday, September 16th,* 1859.)

DURING the last meeting of the Association I had the pleasure of calling the attention of this Section to some of the results of the exploration, then in progress, of an ossiferous cavern, which, early in the year 1858, had been discovered at Brixham, in Devonshire; and though, perhaps, none of the facts then communicated were new to science, yet, when it is remembered that they were obtained from a virgin cavern, which, instead of being ransacked as too many have been, was systematically explored; that the explorations were carefully conducted and sedulously watched; that it was not allowed to regard anything as a trifle, or as unimportant; that the situation of every object was accurately determined by exact measurements, and that everything note-worthy was immediately registered, it will be seen that they have a peculiar value as being perfectly reliable and unquestionably good in evidence. They furnish us moreover with a test, or measure, of the credibility of, at least, some of the facts on record in connection with other caverns, and thus enable us finally to accept or reject them as portions of knowledge.

I regret that the case to which I have now chiefly to call attention possesses no such claims; the facts, such as they are, have come into my possession almost by accident, and mainly from the quarrymen; the cavern, or fissure has been destroyed in the course of the ordinary quarrying operations; there has been no attempt to control or direct the excavation; nevertheless, I am not without a hope that the particulars may be found to possess some degree of interest.

The little village of Oreston is situated on the left bank, and very near the mouth of the tidal estuary of the Plym, which, under the name of Catwater, is one of the harbours that nature has so liberally grouped together at Plymouth. It is essentially a limestone village, being based on, built of, and surrounded by limestone; its chief prospect consists of the limestone-hills and quarries of Catdown, from which Catwater divides it; behind it are the quarries whence the stone for the celebrated Plymouth breakwater was hewn, and its only trade is the exportation of limestone.

It appears from a paper in the Philosophical Transactions for 1817 that "when Mr. Whidbey engaged to superintend that most arduous undertaking the Plymouth breakwater Sir Joseph Banks requested him to examine narrowly any caverns he might meet with in the rock, and have the bones, or any other fossil-remains that were met with carefully preserved."* This limestone is regarded by geologists as the Devonshire equivalent of the Old Red sandstone. Like the limestones of South Devon generally, it is much fissured and broken; hence the expectation that caverns would be found in it was most reasonable.

The result of the request made by Sir Joseph has been the discovery that the volume of limestone at Oreston is a geological classic of great interest. From time to time, portions of it have been translated by the great palæontological scholars, Sir Everard Home, Dr. Buckland, Mr. Clift, and Professor Owen, and given to the world in various forms and publications. Three papers on the subject will be found in the "Philosophical Transactions." Oreston also figures largely in Dr. Buckland's "Reliquæ Diluvianæ," and in Professor Owen's "British Fossil Mammalia and Birds."

The Oreston quarries were opened to furnish the materials for the Breakwater on the 7th August, 1812. In November, 1816, Mr. Whidbey sent up to Sir Joseph Banks his first consignment of bones, with a statement that "They had been found in a cavern in the solid limestone-rock, fifteen feet wide, forty-five feet long, taking the direction into the cliff, and twelve feet deep.

This cavern was filled with solid clay, in which the bones were imbedded at about three feet above its base.

When Mr. Whidbey began to work this quarry, the rock was seventy-four feet perpendicular above high-water; the bones were found seventy feet below the surface of the rock, and about four feet above high-water mark. He quarried sixty feet horizontally into the cliff before he came to the cavern.

Before Mr Whidbey began to quarry here one hundred feet had been quarried into the cliff, so that one hundred and sixty feet was the distance between the cavern and the original edge of the cliff; in all other directions the quarries consist of compact limestone to a great extent. The workmen came to this cavern by blasting through the solid rock, and at the depth in the rock at which it was met with the surrounding limestone was everywhere equally strong and requiring the same labour to quarry it. Mr. Whidbey saw no possibility of the cavern having had any external communication through the rock in which it was inclosed.

"Many such caverns," Mr. Whidbey says, "have been met with in these quarries, and, in some instances, the rock on the inside was crusted with stalactite; but nothing of that kind was met with in the cavern in which the bones were found, so that there is no proof that any opening in the rock from above had been closed by infiltration."†

The above-mentioned fossils were described by Sir Everard Home in a paper embodying Mr. Whidbey's statement, read before the Royal Society, February 27, 1817, and printed in the "Philosophical Transactions" for that year.

---

* Philosophical Transactions, 1817, p. 176.

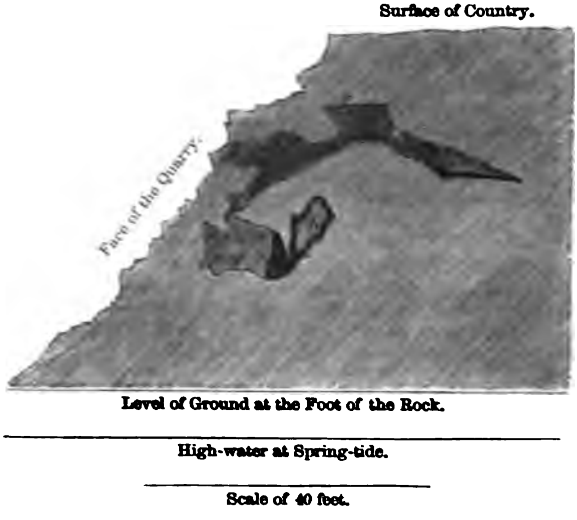
† Ibid, 1821, pp. 133-4.

In November, 1820, Mr. Whidbey discovered a second ossiferous cavern, and sent up the bones found in it to Sir Everard Home, stating that they "were lately found in a cavern one foot high, eighteen feet wide, and twenty feet long, lying on a thin bed of dry clay at the bottom; the cavern was surrounded by compact limestone, about eight feet above high-water mark, fifty-five feet below the surface of the rock, one hundred and seventy-four yards from the original face of the quarry, and about one hundred and twenty yards, in that direction, from the spot where the former bones were found in 1816."*

He then goes on to repeat, almost verbatim, his reasons for believing that the cavern never could have had any connection with the surface.

The bones in this second consignment were, like their predecessors, described by Sir Everard Home before the Royal Society, February 8, 1821, and his paper was printed in the "Philosophical Transactions" for that year.

In 1822 a third bone-cave was found at Oreston, and the fossils sent to London; on this occasion Mr. Whidbey forwarded them to Mr. John Barrow, with a plan and statement descriptive of their situation.


Surface of Country.
Face of the Quarry.
Level of Ground at the Foot of the Rock.
High-water at Spring-tide.
Scale of 40 feet.

Lign. 1.—Longitudinal Section of the Caverns discovered at the Breakwater Quarries, at Oreston, in 1822, by Joseph Whidbey, Esq., F.R.S. Reduced from pl. vi., "Philosophical Transactions," 1823.

[The dark tint in the section marks the places were the bones were found.]

"The height," he says, "of the rock, or quarry, is about ninety-three feet above the top of high-water of spring-tides, which is shown in the sketch, together with a section of the caves where the bones were found. The part where they lay is tinged with red in the caves marked *a* and *b*. The cave *a* is encrusted with thin stalactite: the cave *b* mostly consists of limestone, with bones adhering to the sides; the top is closed up with stone rubble. The teeth and bones found in the cave *a* were mostly covered with dirt; part of them were lying on the dirt, and in crevices about the caves *a* and *b*. From the cave marked *a*, a passage has been discovered into what I call a gallery, marked *c*, which gallery opens into the face of the quarry at *d*. At *e* some teeth and bones were found. The farther end of the gallery is not closed, but it is not sufficiently wide for a man to creep into it. The sides of the gallery consist mostly of limestone, some clay, and stalactite. At *f* the gallery was covered with masses, or lumps of limestone, with much clay intermixed, and in general so compact that it requires gunpowder to blast it asunder—and continued so to the surface of the country, a height of fifteen feet as shown in the sketch.

---

* Philosophical Transactions, 1817, pp. 176-7.

The general state of this quarry has been found to consist of more caves, filled with clay, than any other; and nearly under the entrance of the cave, where the bones were found, I have dug down through clay of so stiff and hard a nature as to render it difficult to dig into it, and it continued so until I got to six feet below high water, when rock again appeared, but not compact. In this digging, many lumps of iron-ore were found in the hard clay.

The distance from the cave *a* to the commencement of the quarry, or harbour, is two hundred and one yards; and to the cave where the first bones were found in November, 1816, one hundred and eighty yards in a western direction."*

The bones found on the occasion just mentioned, together with a smaller number sent up in November, 1822, were described by Mr. Clift, in an elaborate paper, read before the Royal Society, February 6, 1823, and published in that year's "Philosophical Transactions."

On the authority of Professor Owen, the ossiferous caverns and fissures of Devonshire have yielded remains of the following species of mammals, namely:

EXTINCT SPECIES.

Ursus priscus		Ke	O				
Ursus spelæus	Great cave-bear	Ke	O	Ki	G	M	D
Hyæna spelæa	Cave-hyæna	Ke	O	Ki	G	M	D
Felis spelæa	Great cave-lion	Ke	O	Ki		M	
Machairodus latidens		Ke					
Lagomys spelæa	Cave-pika	Ke					
Elephas primigenius	Mammoth	Ke		Ki		M	
Rhinoceros tichorinus	Tichorine (two-horned) rhinoceros	Ke	O	Ki			
Equus fossilis	Fossil horse	Ke	O	Ki	G	M	
Equus plicidens			O				
Asinus fossilis	Fossil ass, or zebra		O				
Hippotamus major	Large fossil hippopotamus	Ke		Ki			D
Megaceros Hibernicus	Gigantic Irish deer	Ke					
Strongyloceros spelæus	Gigantic round-antlered deer	Ke					
Cervus Bucklandi	Buckland's deer	Devon		Ki			
Bison minor			O				
Bos longifrons	Long-fronted ox		O	Ki			

---

* Philosophical Transactions, 1823, p. 78.

RECENT SPECIES.

Rhinolophus ferrum-equinum	Great horse-shoe bat	Ke				
Sorex vulgaris	Shrew	Ke				
Meles taxus	Badger	Ke	B			
Putorius vulgaris	Polecat		B			
Putorius ermineus	Stoat	Ke	B	O?	Ki	
Canis lupus	Wolf	Ke		O	Ki	G?
Vulpes vulgaris	Fox	Ke		O		
Felis Catus	Wild cat	Ke				
Arvicola amphibia	Water-vole	Ke	B	O?	Ki	
Arvicola agrestis	Field-vole	Ke			Ki	
Arvicola pratensis	Bank-vole	Ke				
Lepus variabilis	Norway hare	Ke			Ki	
Lepus cuniculus	Rabbit	Ke	B		Ki	
Cervus elephus	Red deer	Ke			Ki	
Cervus tarandus	Rein-deer		B			
Cervus capreolus	Roe deer	Devon				G

In the above list, initials are appended to the names for the purpose of showing in what caverns the fossils are recorded to have been found, thus: Ke, Kent's Hole, Torquay; B, Berry Head, Ash Hole; O, Oreston; Ki, Kirkdale; G, Gower; M, The Mendip caves; and D, the caves on Durdham Down, near Bristol.

In all there are thirty-three species, of which seventeen are peculiar to the Devonshire-caves. Of these thirty-three, seventeen are extinct, and sixteen still exist, a few of the latter being locally extinct. Three additional species have been found in other British caves, but no traces of them seem, hitherto, to have been met with in Devonshire, namely, the common mouse, *Mus musculus*, found in the Kirkdale-cavern; the wild hog, *Sus scrofa*, found in the caves of the Mendip-hills; and the fallow deer, *Cervus dama*, found, according to some authorities, in the caves at Kirkdale and Paviland.

Of the Devonshire caverns, Kent's Hole has yielded by far the greatest number and variety of specimens, no fewer than twenty-five, perhaps twenty-seven species have been disinterred from that celebrated mausoleum. Next to it stand the Oreston caves, or fissures, where have been exhumed fourteen, or perhaps sixteen species. I find two species, *Cervus Bucklandi* and *Cervus capreolus*, assigned to Devonshire, without the cavern in which they were found being named. Hence nineteen or seventeen, as the case may be, of the Devonshire list are unrepresented in the Oreston series. Two of these, the shrew and the polecat, have been found in a raised beach at Plymouth, about a mile from Oreston.

Some little doubt exists respecting two of the species which some authors assign to Oreston, namely the stoat, or weazel, and the water-vole, as will appear from the following passage in Professor Owen's "British Fossil Mammalia." "Further evidence of the antiquity of the weasel is adduced by Dr. Buckland, on the authority of Mr. Clift, from marks of nibbling by the incisor- and canine-teeth of a small quadruped of the size of a weasel on the ulna of a wolf and the tibia of a horse found fossil in one of the caves at Oreston; and the author of the "Reliquæ Diluvianæ" observes, with his usual acumen, that the weasel's teeth must have made their impressions on the bones of the wolf and horse before they were buried in diluvial mud." The account which Mr. Bell has given in his "History of the Existing Quadrupeds of Britain," of the food and habits of the weasel, is, however, scarcely reconcileable with the idea of its applying its slender acuminate teeth to the act of gnawing bones; and we shall be justified, therefore, in requiring further evidence before admitting the *Putorius vulgaris* into the catalogue of British Fossils, as the associate of the extinct mammalia of the Oreston caves."* That author returns to the subject in the following passage in the same work where he is describing certain fossil remains of the water-vole, *Arvicola amphibia.* "Some of the bones from the cavernous fissures at Oreston show marks of nibbling, which may be referred more probably to the incisors of a small rodent, than to the canines of a weasel."†

The subject is chiefly interesting in its connection with Oreston, as bones of both weasel and water-vole have been found in Kent's Hole, Torquay, and in the Ash-Hole, near Berry Head.

So far as can be gathered from the authors whom I have been able to consult, the following species are, according to the present state of our knowledge, peculiar to Oreston, as they do not appear to have been found elsewhere: namely, the fossil ass, or zebra, *Asinus fossilis, Bison minor*, and the long-fronted ox, *Bos longifrons*—all extinct forms.

In his letter to Mr. Barrow, dated Plymouth, November 9th, 1822, Mr. Whidbey says, "These I think will be the last bones I shall send you from these caves, as they are now nearly worked out. The cave B terminated near where it was first seen; the head of it was closed over with a body of limestone.

The joints of the rock were not so close but that water might drop down into the cave; and about those joints some stalactites were found in small pieces. I have not seen anything to encourage the idea that the cavern had a communication with the surface since the flood; the present state of the quarries shows nothing like it."‡

And so far as he was concerned, Mr. Whidbey was right; they *were* the last bones he sent up; but after the lapse of thirty-six years the quarrymen have found other caverns and fissures rich in bones. I now propose to give such information as I possess respecting this recent discovery.

My attraction was first called to the subject towards the close of last year (1858) by a letter from Dr. Percy, of the School of Mines, Jermyn-street, London, in which he incidentally mentioned that a gentleman had just brought to town some large bones then recently found at Oreston, and he suggested that some attention should be given to the matter. I was at that time closely occupied with the "Windmill-hill-cavern," at Brixham, and could not go down. About the middle of January last, a dealer in geological specimens, at Plymouth, wrote to inform me that a day or two before he had got possession of some fossils which he believed to be of great value, but he gave no other information whatever about them. I took the earliest opportunity of visiting him, and found his fossils to be mammalian remains, just exhumed from a new cavern at Oreston. They consisted of a considerable number of teeth, most of them of herbivores, including the elephant; with a few of carnivorous animals, amongst others the cave-lion and cavern-bear. The owner had not then decided on the price for which he would sell the specimens; but he engaged not to part with them without letting me hear from him.

Circumstances prevented my going to the quarry on that occasion, but early in February I went again to Plymouth, purchased all the bones in the possession of the dealer, visited the quarry, bought up all the bones the quarry-men had, and engaged to take from them all they could find, with the distinct understanding that no other person should be allowed to have any. I may state here that this stipulation did not arise from any monopolizing acquisitiveness on my part, but from a regret, which I have long felt, that entire series of specimens of this interesting character—illustrative of great geological facts, of bygone geographical and climatal conditions, and of extinct forms of life—should be so frequently separated and scattered, no one knew whither; hence I decided on doing my best to prevent such dispersal by purchasing all the specimens, in order to hand them over to the national collection in the British Museum, should they prove worthy of a place there. Since my first visit I have frequently gone to the quarry, and have purchased considerable numbers of bones; all of these, with the exception of my last purchase, are now the property of the nation, and are under the care of the distinguished head of the Natural History department of the British Museum, by whom, I have no doubt, an account of them will be, sooner or later, given to the world, should he find in them any new revelations, or any confirmations or corrections of old and doubtful readings.

---

* British Fossil Mammalia and Birds, p. 118.

† Ibid, p. 204.

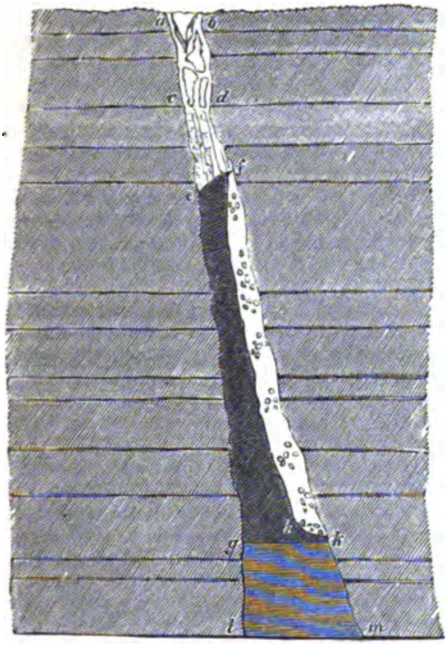
‡ Philosophical Transactions, 1823, p. 88.

My endeavours to preserve the integrity of the series have only been partially successful. One lot has found its way to the Museum at Leeds; another valuable collection has been purchased for the University Museum, at Oxford, by a lady, who on a former occasion manifested her interest in cavern-researches; a considerable number are in the possession of Mr. Hodge, of Plymouth, who has very frequently visited the cavern, and in whom I have found a formidable but at the same time a most courteous rival. So far, however, as these cases are concerned no harm has been done—the specimens thus disposed of would doubtless be readily available for scientific purposes; but it unfortunately happened that a glowing and marvellously embellished account of the discovery appeared in the local papers, thereby awakening a general curiosity in the neighbourhood. Crowds of persons visited the quarries, and eagerly secured—sometimes at heavy prices—what very many of them regarded as astonishing relics, and as incontestible proofs of the occurrence and universality of the Noachian deluge. Such specimens—and I have reason to believe they are very numerous—are probably irrecoverably lost.

I was so fortunate as to find an old man at work in the quarries who had been connected with them all his lifetime. He had seen the foundation-stone of the Breakwater torn from the parent rock and shipped to be transported to its new bed at the bottom of Plymouth Sound. He pointed out to me the line of direction of Mr. Whidbey's caverns, whence it appeared that the new one was in the same line, as if the various caverns had been so many enlarged portions of one and the same original line of fracture.

The Oreston limestone consists of a series of beds varying from one foot to ten feet in thickness, and dipping in a direction south fifteen degrees west, at an angle of about thirty-two degrees. The artificial cliff produced by the quarrying operations of half a century is, at present, about sixty feet high; its base is one thousand and ninety feet from the quay, or river-margin, and fifteen feet above the level of high-water at spring-tides; hence the new cavern was about four hundred and eighty-seven feet from Mr. Whidbey's third cavern, five hundred and sixty-eight feet from the second, and nine hundred and thirty feet from the first—that is, the first cavern, or fissure, was one hundred and sixty feet from the river- or original face of the cliff; the second occurred three hundred and sixty-two feet beyond this, in the mass of the hill; eighty-one feet further, in the same direction, disclosed the third; and a further advance of four hundred and eighty-seven feet brought the workmen to the fourth, *i.e.*, the cavern discovered last winter.

This cavern was ninety feet long, and extended in a direction from north-north-east to south-south-west, or very nearly that of the dip of the limestone-beds. It commenced about eight feet below the top of the cliff, and continued to its base, so that it is about fifty-two feet high; indeed its height exceeds this, as the bottom has not been reached. At the top it is about two feet wide, gradually increasing downwards, and reaching a width of ten feet at its bottom. The first or upper eight feet were occupied with what the workmen called "gravel," which consisted of angular portions of the adjacent limestone, mixed with a comparatively small amount of sand. The limestone debris varied in dimensions from fragments of the size of hazel-nuts to pieces ten pounds in weight. This accumulation was entirely free from stalagmite, and was in no part cemented. No traces of fossils were found in it. The next thirty-two feet in depth were occupied with similar materials to those just mentioned (the sand being somewhat more abundant), with the addition of a considerable quantity of tough, dark, unctuous clay.



Lign. 2.—Vertical transverse section, on the scale of 1-20 inch to the foot, of a Cavern discovered at Oreston, near Plymouth, in the winter of 1858-9.

a, c, d, b,	Roof of Cavern, composed of large angular masses of limestone.
c, e, f, d,	"Gravel" of the workmen, *i. e.*, angular limestone, with a comparatively small amount of sand, the whole uncemented.
e, g, h, f,	Angular limestone, sand, and tough dark clay with bones.
f, h, k,	"Callis" of the workmen, *i. e.*, a nearly vertical dyke of stalactite, with masses of limestone-breccia, the whole containing bones.
g, l, m, k	Tough dark clay without traces of bones.

Between this mass of heterogenous materials and the western- or what may be called the river-wall of the cavern there occurred a nearly vertical brecciated plate, or dyke, which the workmen denominated "callis," extremely tough, and quite as difficult to work as the compact limestone itself. The only means of severing it was by blasting; and being considerably less compact than the limestone, the expansion of the ignited powder told on it with much less effect. It may be described as an approximately vertical plate of stalactitic carbonate of lime, containing, at by no means very wide intervals, masses of breccia made up of the materials just named as composing the accumulation in contact with and on its eastern or hill-side, and cemented together by carbonate of lime. Some of these masses measured fully a yard cube, but the general thickness of the "callis" was about two feet. This was the bone-bed, that is to say, the bones were found alike in the "callis," and in the mass of heterogenous materials beside it, in the cemented and uncemented portions of the bed. They were found alike at all heights or levels, in the lumps of breccia, in the pure stalagmite between them, and in the looser and less coherent portion of the accumulation, thereby suggesting that the cavern was slowly and gradually filled with limestone-debris detached from the rock in which the cavern occurs, with sand transported at least from some distance, and with mud, not each in definitely successive periods but together, with occasional pauses, or periods of cessation; the proof of such pauses being the frequent presence of the portions of pure stalagmite separating series of brecciated masses made up of angular limestone, clay, and sand, lying one above another in the same nearly vertical plane. The rapidity of the infilling, and hence the time required for the process, seem of necessity to be measured by the rate of deposition of the stalagmite, whatever that may have been. It appears, too, that throughout the entire period—be it long or short—required for and represented by the accumulation of the materials now under consideration—alike during the periods of active, and of tardy accumulation—bones of various animals were introduced and inhumed, and that there was no marked cessation in this part of the work, since the bones were found as frequently in the pure stalagmite as elsewhere. In that portion of the series which is destined for the University Museum, at Oxford, a mass of this stalagmite will be found containing a fine jaw with teeth, beautifully white and entirely free from any trace of soil. The bones are frequently in a very fragmentary condition, many of them being mere splinters, as if broken by fragments of rock falling on them; this, however, may be partly due to the rough handling of the workmen in extracting them.

"I always know," said the old quarryman before alluded to, "when we are coming to bones where there's clay, for the clay is always fat-like. I suppose 'tis the fat of the beasts that the bones belonged to." Evidently he was not enough of a philosopher to explain phenomena by calling to his aid the "plastic," or the "sportive powers of Nature;" and probably he was so benighted as never to have heard of the discovery of "prochronism."

A somewhat considerable number of clay-balls, generally ellipsoidal, and varying from an inch and a-half to two and a-half inches in greatest diameter, were found in the clay throughout the bone-bed, but not above nor below it.

Beneath the mass of materials just described, occurs a bed of dark, very tough, unctuous clay; known to be twelve feet thick, but perhaps more, as its base has not been reached. It seems to be of the same character as that mentioned by Mr. Whidbey in his description of the third cavern, already quoted. Occasionally it contains a few very small angular stones, but with this exception it is perfectly homogenous. No traces of fossils have been found in it.

It now remains to consider how the contents of the cavern were introduced. The workmen most positively assert that it never was an open fissure; that the roof, eight feet in thickness, was of sound unbroken limestone, and that the stones and other materials could not have fallen in from above; but then, unfortunately, they, with equal positivity, affirm that there was no external opening whatever—vertical, terminal, or lateral; and, in their endeavours to account for the presence of the bones and rock-debris in what they believe to have been merely a blind cavity in the rock, they incline to the opinion that the rock has grown round the accumulation which it contains—just as some persons ask us to believe that rocks have grown around live toads and frogs.

It will be remembered that in Mr. Whidbey's description of the two first caves he most decidedly gives it as his opinion that there never were any indications of a communication with the surface; indeed, in his first letter "he saw no possibility of the cavern having had any external communication through the rock in which it was inclosed;" and although in his letter to Mr. Barrow, descriptive of the third cave, he admits that "there were joints not so close but that water might have dripped into the cavern," he adds "I have not seen anything to encourage the idea that the cavern had a communication with the surface since the flood."

In his "Reliquiæ Diluvianæ," Dr. Buckland, who had visited Oreston, says, "In speaking of the bones at Oreston in my former paper on Kirkdale, I had expressed a decided opinion that the caverns in which they occur must have had some communication with the surface, through which the bones may have been introduced; and Mr. Whidbey has since found reason to adopt the same opinion."*

The late Sir Henry de la Beche, in his "Report on the Geology of Cornwall, Devon, and West Somerset," says "In one of our visits to the Oreston quarries we obtained two teeth of a rhinoceros at the bottom of a narrow fissure, amid a dark clay, apparently impregnated with animal-matter, in an old unnoticed part of an excavation. Considerable angular masses and smaller fragments of limestone often occur in the ossiferous and other fissures, and it can be readily understood that before these cracks became filled by fragments detached from the sides, and by the loam and sand, multitudes of animals ranging the ground above could have fallen into them, more particularly when chased by beasts of prey, often themselves the victims of their own eagerness and voracity either during the chase, or when the dead animals were visible in the fissures."†

As the workmen entered the cavern at the top, in the ordinary course of working vertically downwards the greater part of the roof was destroyed before I visited Oreston; nevertheless a portion, and, I think, a sufficient portion for the purpose, remained. It was evidently a mass of limestone-breccia, made up of large angular fragments cemented by carbonate of lime, and easily enough mistaken, without a careful inspection, for ordinary limestone somewhat rich in coarse veins. I called the attention of the workmen to it, and explained my opinion respecting its origin; to this they offered no objection further than that it was solid, and required blasting quite as much as the limestone elsewhere. This appears to have been Mr. Whidbey's test; for, in his first letter to Sir Joseph Banks; he says, "In the contract of quarrying there are two prices, one for rock, another for clay, earth, and rubbish; and two officers attend, one for the Crown, and the other on the part of the contractors, who measure the contents of all caverns that contain clay, or other soft materials: it is only necessary to mention that these officers state that the rock surrounding the cavern was equally hard with the other parts, requiring the same force to blast, and that the quarrying was paid for accordingly."‡

---

* Reliquæ Diluvianæ, page 80.

† De la Beche's "Report on Cornwall," &c., p. 113.

‡ Philosophical Transactions, 1817, p. 177.

Whether that part of the roof which had been destroyed before my first visit was unbroken rock or breccia, cannot now be determined, but its removal had exposed the surface of the wall of a nearly vertical fissure throughout the entire length of the cavern, which by its soil-stained surface distinctly showed that water, plentifully charged with mud, had had free access into the cavern from the surface; or, in other words, that at least a line of fracture had extended from the cavern upwards to the surface throughout the entire length of that portion which is not known to have had a brecciated roof—that is, to have once been an open fissure. My own opinion is that there is ample reason for believing that the cavern originally communicated with the surface by an opening sufficiently wide to allow the passage of all its contents, and that it was thus filled; but whether animals fell, or were dragged in, or whether the bones found there were wholly or partially the disjoined remnants of dead animals washed in, I will not undertake to say. There seems nothing to prevent our supposing that some of the bones were introduced by one of these modes, and some by another. I cannot but think that some of the bones appear to have been rolled, as if they had been washed in; whilst if, as Sir Henry de la Beche supposed, the loam, or clay, is really impregnated with animal-matter, it seems reasonable to infer that, at least in some cases, something more than mere portions of the osseous system was introduced.

The workmen state that from the southern extremity of the cavern, just described, a low narrow passage or gallery leads into another cavern, which they say is "about the size of a room;" not a very definite unit of measure, but judging from their account, it must be rudely a cube of about twelve feet in the side. It does not seem to contain any fossils. Ever since my acquaintance with the locality commenced, the entrance to this gallery has been completely blocked up with the ordinary quarry-refuse, but this I hope will shortly be removed, so that it may be explored.

My object in this paper has been to endeavour to keep the subject of caverns somewhat prominently before geologists, for, unless it is believed that further cavern-researches would be superfluous; that we now know all that caves are capable of teaching; and that whether they are left undisturbed, are ransacked and rifled, or systematically explored, science will in no way be affected thereby, I cannot but think it desirable to organize some scheme for the purpose of exploring and reporting on our British caves. Oreston has slipped through our fingers; the workmen have had the cave under their management, or rather mismanagement; the specimens have been badly exhumed; they have been dispersed beyond the power of science to recover them; the materials in which they were deposited have been carted away without examination, whether they contained any of the articles known as "flint-knives," or any other of the supposed indications of human existence is not known, and never can be known.

Oreston is altogether silent on the question of "Man among the Mammoths;" and this, too, will be the fate of the caverns at Buckfastleigh, at Yealmpton, at Ogwell, and at Chudleigh, unless science puts forth her hand to save them. A recent visit to the celebrated "Kent's Hole" convinced me that there is much virgin-ground yet to be broken there.

Without the pale of philosophy exists a many-motived curiosity on this subject, quite as powerful, if not so intelligent or manageable, as that which leads, yet is under the guidance of, science. Recent discoveries and discussions have made it not a question of exploration now, or at some future time; the alternatives are prompt systematic investigation, or the abandoning of our caverns to be ransacked by fossil-dealers.

NOTES AND QUERIES.

Notes of a Geological Tour in Wharfedale.—I know no district in England that contains such scenes of varied beauty or grandeur as the valleys and hills that form the north-western corner of Yorkshire. I have spent years among them, and they are still fresh to me, and present ever-changing points of interest. Savage, as where the wild heath-covered hills of the Millstone-grit lie around with an almost illimitable horizon, the clouds in passing cast their shadows over them as they do over the sea; or where the grass-grown ledges of the lower "scar-limestone" stretch away along the mountain-side, like giant stairs up to the purple hills that swell in great bosses from their rocky platform; or where the mountain-torrent bursts its way between black beetling walls of precipices riven by the catastrophes of an older world. Picturesque, as where the streams have cut their way deeply into the "Yoredale-rocks," whose "scars," bleached and worn, peep through the thick woods that creep up the steep sides of the ravines, or stand out bare and gray above them, like the torn ruins of a mighty fortress. Beautiful, as where the trickling rills steal into some still pool, where the damp rocks are green with mosses, or the richly coloured lichens and jungermannia form a bed, overhung by the graceful fern-fronds; where thick masses of young ash and maple fill up the hollow banks, through which rise the tall purple foxglove and the pale flowers of the giant campion like fairy sceptres, while over all the tall elms shut out the light, or admit it only in broken gleams to play among the leaves, or sparkle upon the breaking water, murmuring as it ripples over the edges of the dark pool to find its way again to the sunshine. The lover of the beautiful will everywhere find himself well repaid for his exertions; but the naturalist, and especially the geologist, will nowhere find objects of higher interest, more finely developed instances of geological phenomena, or a more plentiful harvest of fossils to reward a hard day's work.

Of these mountains and glens few equal, none excel, either in their stern or gentle beauty, or the interest of their geological relations, the valleys of the Wharfe and Nid, or the mountain-masses of Great Whernside and Buckden Pike; and in this short paper I will endeavour to point out some of the many spots interesting to the geologist, through which we passed in the course of a summer excursion, indicating a few of the localities for fossils, and the less known beauties of the district—far too seldom visited, though so near to places like Ilkley or Harrogate, where the *habitués* are eaten up by ennui, and languish for something fresh to see or to do.

Before I proceed further, I would wish, however, to sketch very briefly the nature of the strata which are exposed in these dales. The formation is the Carboniferous-limestone, divided by Phillips into five main sections. In Wensleydale to the north the whole of these divisions is well developed, viz., in descending order:

1st (or uppermost), The Millstone-grit group, a series of sandstones and argillaceous beds called "plate," with many seams of stony or impure coal, and a few thin bands of limestone in its lower portion. These rocks cap the highest hills of the district; but towards the east they spread out into wide moors till they disappear under the magnesian-limestone of central Yorkshire towards the north under the Durham coal-field. Their thickness varies from . . . . 100 to 400 feet.

2nd (*a*) The upper "Scar-limestone," consisting of two thick beds of blue limestone, divided by thin layers of sandstone and "plates," and one bed of coal, which is not continuous. The upper limestone—under the names of Camfell-, Main-, Parkhead-, and Twelve-fathom-limestone—is one of the most constant in the district. The greatest thickness of this group is . 200 feet.

(b) A group of flagstones, called the "Hawes-flagstones," from their great development at the head of Wensleydale; it contains one strong band of limestone, and a great thickness of gritstones and "plates," very varied in their character. The thickness of these flagstones is . . . . . 500 to 600 feet.

(c) The "Black-limestone" group containing two well marked beds of limestones, the lower one of which produces the grey encrinital marble of Dent, with "plates" and grits. Its thickness is . . . . 200 to 300 feet.

3rd. Below this is the lower "Scar-limestone," of a much more homogenous character, the thickness of which, as it forms the bottom-rock of most of the valleys, has not been accurately measured. It cannot, however, be less than . . . . 500 feet.

The general dip of this series is south-east, and in following the beds in that direction to their disappearance under the magnesian limestone and New Red sandstone, the thickness of groups *a*, *b*, and *c* becomes gradually less by the obliteration of the two lower series first; and finally by the thinning out and complete disappearance of the upper one, until in Wharfedale and Nidderdale the Millstone-grit reposes directly upon the lower "Scar-limestone," which has increased in thickness until, from being the bottom-rock of Wensleydale, it almost reaches the top of Great Whernside, and forms the sides of the deep valley of the Wharfe.

But another cause has been at work to alter the face of the country besides the gradual change in the thickness of the beds. On a curve, drawn from Settle to Harrogate, at the foot of the dales that fall to the south from the chain of hills skirting the southern side of Wensleydale, the lower "Scar-limestone" appears to abut against, instead of underlying, the Millstone-grit. This is caused by a downthrow of the latter, on the line called the "Craven-fault," which beginning near Kirkby Londsdale, where the limestone and the Cambrian slates have their relations much altered, may be followed towards the east, in which direction it breaks up the limestone itself, as in the district of Craven, and still further east disturbs the position of the limestone and the Millstone-grit, until at Greenhow-hill the last traces of it are exposed before it disappears under the Magnesian-limestone, which being a later formation has covered up all tokens of the disturbance.

Whenever the streams run through the upper "Scar-limestones" their general course is eastwardly, with a slight tendency to curve to the south; but as soon as these beds disappear, and the lower "Scar-limestone" comes uppermost, we find that the valleys turn southward until they reach the line of the Craven-fault, when they follow again the natural dip of the beds. This fault thus becomes the cause of much of the variety in the character of the scenery of these Yorkshire dales.

Our road lay out of Wensleydale, up one of its lateral valleys called Bishopdale, and over Kidstone's Pass, a route practicable for carriages, which can be said neither of the pass to the right out of Raydale, over Stake Fell, nor of that to the left out of Coverdale, over Buckden Pike, although both are sometimes attempted.

All the valleys out of Wensleydale are either destitute of roads leading southward, or the passes are excessively steep on their southern faces. This fact is connected with another in the physical geography of the district; viz., that Wensleydale is bounded to the north by an unbroken chain of hills, while on the south five large valleys run into it. Swaledale and Teesdale are [illegible] destitute of direct lateral valleys from either the south or north.

The reason of this appears to be that south of Wensleydale the upper "Scar-limestones" thin out; while the lower, which form the bed of the Eure, thicken in proportion, thus creating a basin on which the upper group reposes, while the passes to the south lie on the edge of this great basin, which may be traced round by the line of the "Penine-fault." The grits of the upper group, especially where the beds become obliterated, are friable and easily broken; hence the streams flow on the more compact lower strata, and find their way from their springs on the edge of the basin into the hollow where the main river runs, creating the lateral valleys which, from the enormous thickness of the beds, and the greater strength of the limestone-bands, is impossible on the northern face of the main valley; and the descent into the valleys south of Wensleydale being from the edge of the basin through the steps of the great homogenous lower "Scar-limestone," which has few alternating grits and "plates" to wear level, the roads, where there are any, are more impracticable.

At Cray, the first hamlet in our descent from the pass, we found crossing the road, a little above the inn, several highly fossiliferous beds, where the *Productus Scoticus* is crowded together in the thin stratum which produces the large slabs containing that fossil so common in our museums. It is associated with *Lithostrotion irregulare* in very large lumps. A little above this are beds in which *Turbinolia fungites* is very common; while higher, where the waters form a series of cascades, the beds are full of *Productus giganteus.*

The descent from above Cray into Wharfedale is very steep; and passing a valley to the left, a view opens into the heart of Great Whernside, its rounded top forming a prominent object; we soon came in sight of one of the marvels of the dale—Kilnsey Crag, a magnificent scar, one hundred and sixty-five feet perpendicular, and literally overhanging the road for half a mile. It is in the the lower "scar-limestone," and one of the spurs of Hard-flask, a range of hills stretching as far as Pen-y-geant; and, lying in the northern line of the "Craven-fault," probably owes its perpendicular character to the disturbances that produced the precipices of Malham Cove and the scars at Giggleswick. From beneath it, as at Malham Cove, issues a clear stream of cold water, whence Whittaker deduces the name of the crag itself, "Kilnsey" (written chilisie), that is, "chill water," a derivation almost too poetical to be correct.

In the drive from Kilnsey the valley yields a succession of views of the most romantic and ever-increasing beauty, until they culminate in the rich woods and savage moors by which Bolton Abbey is shut in. On the left, at the base of Whernside, the step-like character of the "lower scar-limestone" is well exhibited.

We did not follow the road further than to a village called Linton, where we turned off into a bye-road that led us into a little solitary basin among the hills, where lies the hamlet of Thorpe, called in the old charters "Thorpe subtus Montem," and truly it deserves the name. It lies in a hollow of the limestone, where the beds are broken up at the junction with the millstone-grit, which frowns in castle-like "scars" from Burnsall and Barden Falls. The limestone itself, after its disruption, has been worn into conical hills and lake-like cavities, not dissimilar to the way in which it has been denuded near Clitheroe; while the beautiful green herbage on the sugar-loaf hills presents a striking contrast to the brown rocks forming the edges of the millstone-grit above them.

This limestone is most fossiliferous; and contains very fine examples of many species of Productus, Terebratula, Rhynchonella, and other brachiopods, and fewer, but equally well preserved specimens of Trilobites, Goniatites, Pectens, and beautiful corals. We brought away with us, after a long day's work, a noble series of fossils, many of which would grace the cabinets of the most fastidious.

A day at Thorpe would well repay the collector of fossils; and Messrs. Pindar, who were most obliging to us, would I am sure be most happy to render any facilities.

Missing Malham Cave, we followed the line of the "Craven-fault" to Settle, where its grandest features are displayed in the deep valley of Austwick, and on the upheaved masses of Feizer, and the magnificent scars of Giggleswick, above Austwick. High up, nearly on the upper platform of the limestone-cliffs, our friend Mr. Burrow, whose collection of Craven-fossils is almost unique, pointed out to us a cove in the scars, the bottom of which was covered by great blocks of Silurian slates, many of them standing upon the edges of the weathered limestone like logging-stones and cromlechs, the stone upon which they were placed having worn away much faster than they had themselves. The locality and the position of these stones seemed at first to mark the site of an ancient glacier. There was, however, no evidence of glacial markings; and the slate-rocks were too high above their place *in situ* to allow of such a supposition. They appear more likely to have been the jetsam of stranded icebergs that had floated off from a glacier debouching upon a half-frozen lake; but the place is worth a visit, and it cannot be missed by anyone who inquires at Austwick for "the moor where the black stones are."

Further eastward, under Moughton Scars, magnificent sections of the Silurian slate-rocks underlying the limestone are exposed, especially in the quarries at Horton, in Ribblesdale. The rocks most disturbed in the line of the fault yield localities very rich in fossils.

I will not dwell on our journey from Skipton to Bolton Abbey, nor from thence by Greenhow Hill to Paleley Bridge, except to remark that Greenhow Hill deserves a better description than I can give of it. At Nursa Knot, part of Greenhow Hill there is an anticlinal axis, where the "lower scar-limestone" is thrust up through the Millstone-grit. Want of time, idleness, and illness prevented a close examination of it, which it would well repay, and more especially if an exploration of the lead-mines at Craven Cross could be arranged at the same time.

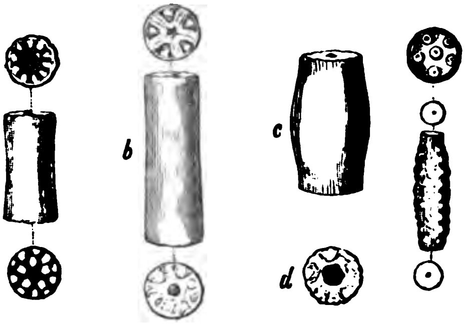
Nidderdale is one of the pleasantest little valleys in England; its meadows are luxurious as a summer Alp; its streams flow full and sparkling, in beds of limestone through deep fringes of richly foliaged timber-trees. Thick plantations line its sides, and either run up to and over the summits of the hills, or only just permit the brown crags of the Millstone-grit to peep over the tops of the firs. Towards the head of the dale these woods disappear from the hills, and only hold their place in the deep ravines ploughed out by the mountain-torrents. In one of these the infant Nid disappears into a yawning cavern, called "Goreden Pot-hole."

In following the valley downwards, the ravine seems to be blocked up by a gigantic precipice of limestone, under which is a deep tunnel, and into this the stream rushes and disappears amongst the huge rocks that are heaped one on another in this gigantic portal. The blue mist comes eddying out into the hot air, and if you enter within, the cave is as chill as an ice-house. The white precipice is fringed with ash and alder, and the thick woods that fill the ravine make it dark even at a summer's noon. The bizarre shapes of the rocks, the yawning entrance, and the swallowed-up river would, among a people more romantic than Yorkshiremen, have given rise to many a legend of fantastic superstition. There it is so little thought of, that a few miles off the natives scarce know of its existence. In rainy weather especially it is worth a day's journey to visit it.

Two miles below this "swallow-hole" the river issues out of the hill-side from beneath two natural rock-arches in a full clear stream, called "Nid-head;" but if not particularly inquired for in the district, the place will not be pointed out by the villagers. Both these localities are within easy distance of Harrogate, which lies in the throat of the valley, and through which runs the only good road into Nidderdale, all the other roads out of it on each side being excessively steep and awkward. For a pedestrian, however, nothing can be finer.

On leaving the Nid, the tourist may visit Brimham Rocks, which lie among the moors on its northern boundary. We crossed over them to Hackfall and Masham; and our last glance at the purple swells of the heathery moors was one of regret—almost of pain—at leaving the fresh breezes and the wide horizon for the close hot dales and still closer, hotter, smoky towns of Yorkshire.—Edward Wood, F.G.S., Richmond, Yorkshire.

Plates of Bourgueticrinus.—Dear Sir,—You will find on the accompanying woodcut figures of extremely rare forms of Apriocrinites, or stem-plates of the crinoid, now more commonly called by D'Orbigny's new generic name of Bourgueticrinus, instead of the former term given to these fossils by Miller.



[Specimens of stem-plates of Bourgueticrinus from the Upper Chalk of Kent.]

Fig. *c* is represented on account of its unusual size. It is from Kent. This is not in my collection, having been lent to me many years since. All the specimens figured on the block, as also others with remarkable articulations in my collection not yet been figured, are from the Upper Chalk of Gravesend.

In Dixon's Geology of Sussex, table xx., figs. 37, 38, are two stems allied to mine. On reference to Morris's catalogue, page 73, I find other forms besides the *B. ellipticus* have been published by D'Orbigny and McCoy.—Very truly yours, N. T. Wetherell, Highgate.

Observations upon Certain Geological Inferences.—Sir,—I have carefully considered the strictures which you have thought proper to append to my communication, for the acceptance of which I thank you; and I am sure that you will allow me some opportunity of extricating myself from the apparently unfortunate position in which your remarks have placed me; which I shall consider in order.

To say that granite is only a crystalline condition of rock, is just the same as saying that ice is only water minus a certain portion of its latent heat. It is rock in this condition which constitutes granite; and inasmuch as we could not decide whether any given uncrystallised rock would become granite upon igneous agency, because we have never experienced the operation, it is useless to talk of any rock which, if subjected to igneous agency, would become granite, not knowing whether such constitutes any portion of the earth's crust. I do not understand your meaning when you say that granite may be coeval with the newest of the Tertiary formations. You cannot mean to say that its formation is synchronal with the London clay, for example? As regards rocks dipping into it, I am aware that gneiss and other metamorphic rocks unite a crystalline structure with stratification, and thus somewhat resemble those of purely igneous agency; but my language applied to rocks of a purely aqueous origin, so that we agree on this point. It is not well in making a few general observations upon any science to encumber oneself with minor considerations, nevertheless the metamorphic rock could hardly be urged as an objection to what I have said, inasmuch as the gradual amalgamation you have spoken of could not be fairly construed into dipping. In speaking of granite I must include the various species of this substance. If I am supposed to err in calling it the oldest rock, I shall be obliged if any person will offer some reason for rejecting this opinion; when, both as regards this and every sentiment I have offered, I shall, if convinced of the falsity of them, be the first to own it.

You inform me that my remarks on the time requisite for the formation of strata, prior to historical times, are more illogical than the deductions of the geologists I refer to; but I think I can show that this is not the case. If I supposed that my argument had no better foundation than you appear to discover about it I should indeed have kept it to myself. I absolutely deny that I have simply denied the truth of the notion contested: there is a substantial reason for supposing that the earth was formed in a short space of time, apart from geological considerations; and until geologists prove that the peculiar appearances connected with strata formed prior to historical times cannot be explained without the supposition of the formation having extended over a vast period of time, I cannot assent to the truth of their hypothesis. You perceive I have assumed that these rocks present features which are not found in those of a later date which have been formed gradually; nevertheless, I confess that I have never been enabled to discover in what the peculiarities consist, and should, therefore, be glad to learn what they are, if any exist. If these ancient rocks present a different character to those more recently and far more slowly formed, for once adopting an hypothesis as true, it only proves that their mode of formation must have been very different, and that it must have been very rapid, because that of later rocks has been slow. Consequently, if any such peculiarities exist, they only prove the opposite of what geologists at present profess to draw from them. If many geologists have not considered this, I wonder at it. If the peculiarities of character alluded to really exist, they certainly must prove that the formation of the rocks cannot have been similar; and, as we know that recent rocks, using this term in its geological sense, have been slowly deposited, they prove that the earlier ones must have been very rapidly formed. It may be thought that they would prove that these rocks were deposited far slower than the others, or that this supposition is as likely as the other; but many considerations show that this hypothesis lacks consistency. I doubt, however, that such peculiarities exist, or any, if any can be found, which cannot be explained by the age of the strata they characterize.

My reference to the Mosaic record, so far from being illogical or unphilosophical, appears to me to constitute a sound proceeding. From that account I gather some reason, if I was sure that I understood it as it is intended to be understood, I should say irresistible reason for supposing that the earth was created in a short space of time. Geologists inform us that this was not the case, and surely I am not illogical in demanding a satisfactory reason for their opinion, before acquiescing in it. It is often said that the two records, nature and revelation, should not be confused together; but, while agreeing with this, as regards scientific investigation in general, I maintain that the obvious meaning of Scripture should not be considered figurative, before science has fully proved that truth renders this necessary. In my third question, which you very indefinitely condemn, I have given a supposition made use of by Dr. Lardner, which appears to me highly probable. From your remarks about the perusal of geological writings as a principal mode of obtaining a knowledge of this science, I apprehend that you consider my observations somewhat "bookish," to use a term sanctioned by Locke. As to the supposed difficulty how rapidly precipitated rocks should contain myriads of organic remains, I never asserted that this need be supposed. The stratified rocks may have been very rapidly formed, after which the earth may have undergone such revolutions as to account for the various periods supposed, consequent upon the presence of certain fossils and remains, and the individual appearance of these in various strata. This would embrace the first five verses of the Mosaic narrative, and, geologically, the so termed pre-adamite periods. There is no occasion to imagine the first five and following verses of the Mosaic narrative as describing events immediately consecutive, as other writers have observed; and it is probable that the harmony of the two records renders this necessary, inasmuch as the conjecturable events of the Deluge cannot be supposed to account for the fact of certain fossils and remains being exclusively found in certain strata.

I think that you will now consider my former observations less unfavourably than before. They certainly did want some explanation, which I have now endeavoured to furnish. There is certainly nothing, even in the humblest truths of geology, to excite merriment; nevertheless, absurd conclusions with regard to this or any science deserve no more.—I. A. DAVIES.—We print Mr. Davies remarks in full, but without comment, having laid down a rigid rule, from which in no case shall we depart, namely, of not entering into any controversial communications. We abide by our former remarks.

THE PRE-ADAMITE AGES.—SIR,—I believe that geologists have not yet decided how many distinct revolutions of animal existence the earth had seen prior to the era of man. Now, inasmuch as we cannot say how many and what species of strata were simultaneously uppermost, I do not see how this question can be decided. The various fossils found in the three great series of rocks cannot, in my opinion, decide the point, inasmuch as the various strata uppermost at various times remain unknown. And as an inquiry analogous to, and perhaps somewhat connected with this, the supposed knowledge of rocks beyond the range of our experience should be noticed. We cannot, from the nature of the case, say positively how rocks unseen by human eye are situated with respect to one another, for which reason I cannot make much of the various theoretical sections of the earth's crust which geologists sometimes frame, and with which they, in my opinion, more mystify than enlighten their readers. It is true that we may make probable conjectures concerning these matters, but absolute certainty is out of the question, until direct evidence has been obtained; which of course can never be the case. Yet we may be more certain with regard to other phenomena of unseen rocks. Granite, or the granites, for example, may, from their obvious quantity, perhaps according to appearance exceeding that of any other rock, and their possessing certain chemical and, especially as regards durability, mechanical principles, be regarded as the oldest and lowest rocks, forming the inner side of the earth's crust; and being, consequently, in direct connection with the matter of volcanos.—I. A. DAVIES.—There is no reason to suppose that there have been any given number of distinct revolutions of animal existence; the changes have been gradual and successive, without any general and total break. The arbitrary divisions for scientific grouping must not be mistaken for real gaps in the order of nature.

ORIGIN OF THE METAMORPHIC ROCKS.—SIR,—I think that the difficulty respecting the origin of these rocks is considerably reduced upon the adoption of an hypothesis, made use of by Dr. Lardner, respecting their gradual precipitation upon those of an igneous nature. By this it stands to reason that they would acquire a crystalline nature. Thus some of the ingredients found as components of granite and other igneous rocks would be developed. This may be supposed to be the effect of heat, which would affect what would otherwise be ordinarily stratified rocks. I consider that this hypothesis is much strengthened by the fact (assuming, as from the nature of granite I think I may, that this geological doctrine is a fact) that these rocks underlie those properly stratified and fossiliferous. The metamorphic rocks appear to be ordinary stratified rocks subjected to the influence of heat. The hypothesis alluded to, if accepted as true, or even probable, explains their position. The heat of the igneous rocks would not reach those purely sedimentary, but only alter rocks with which they were directly connected. If it be said, as it has been, that some metamorphic rocks do not exhibit the influence of heat, I advise that the objectors consider the effect of age upon any deposit; and also the way, the possible way, in which this phenomenon can be accounted for, if they can discover any, and reject this explanation. I do not see what other explanatory hypothesis can be found.—I. A. Davies.—How sedimentary matter or any precipitate could be derived from highly heated basement-rock, as Lardner's hypothesis requires, it is difficult to conceive. As altered sedimentary matter (sand, clay, and limestone) the materials of the metamorphic rocks might plainly have come from the waste of the first uprising lands.

The position of the metamorphic rocks in relation both with the igneous rocks and unaltered sedimentary rocks affords incontrovertible evidence of their having been usual sediments altered and distorted by heat.

Suggestion respecting Rock-basins.—Sir,—Whilst reading in your periodical for August the interesting article by Mr. Rupert Jones on the weathering of granite, a conjecture presented itself to me as to the probable cause of the primary basins on some of the surfaces of the granite. It is this—whether the basins, if they correspond with distinct masses of rock, may not be produced by the shrinking of compressed cooling masses. I might add in illustration, I conceived that a like process might occasion the concave and convex joints in the basaltic pillars at the Giant's Causeway. This is merely a suggestion, which may or may not be tenable; if it be, you are quite at liberty to publish it should you think fit.—Yours respectfully, George Renning, Sheffield.—Our correspondent will see in Mr. Rupert Jones' paper, at pages 307 and 308, that the effects of contraction in cooling have not escaped observation; and he will further see, at page 311, that Mr. Ormerod recognizes the horizontal planes of fracture or fissurage as probably limiting the depth of at least some of the basins. We may take this occasion, in reference to the remarks of our correspondent, Mr. Drake, in our September number, on the artificial origin of rock-basins, to express our regret that Mr. Rupert Jones did not refer to that interesting aspect of the subject; probably he wished that readers should refer on this point to Mr. Omerod's valuable memoir from which he largely quoted, and in which will be found some observations on the circular cavities in boulder-blocks in stream-courses, to which class of basins Mr. Drake refers in the latter part of his communication.

Localities for Mammalian Remains.—Bones of elephant, rhinoceros, and ox from the gravel, at Brockhall, Lawford, were presented to the Geological Society, in 1833, by the Rev. Wm. Thornton. Shells, and bones of mammalia, from Stutton, Suffolk, were also presented by Mr. Edw. Charlesworth in 1835. —F.G.S., London.

REVIEWS.

Natural History of the European Seas.—By the late Professor Edward Forbes and R. A. Godwin-Austen, Esq., F.R.S.

If anything could give us pleasure, and at the same time pain, it would be to review a posthumous book of Edward Forbes—we write not the prefix "Professor," for the two simple words are their own glory, the reality of which no addition could increase. Amongst the very earliest of our encouragers in the pursuit of natural history we remember, as many, many others in their own cases must do the like, the amiable courtesy and gentleness with which that great man would at all times assist our inquiries by the ready explanations which his vast-extended knowledge enabled him instantly to give.

One half the book before us was penned by Edward Forbes, the remainder has been completed by his friend—indeed a treasurable title—and literary executor, Mr. Godwin-Austen. Well-known and appreciated for his scientific acquirements, in no better hands than his could such a task have been placed; but all the world knows how charmingly, and yet how philosophically the professor wrote; and in few tasks, therefore, could it be more difficult to acquire a successful result than in the completion of an unfinished work, however simple might be its character, of a man esteemed alike as an individual, an author, and a philosopher.

The history of the present volume, one of Mr. Van Voorst's projected series of "Outlines of the Natural History of Europe," is briefly told in the preface. Three books under the above title were proposed some years since to be issued; Professor Henfrey undertook the subject of the "Vegetation of Europe," Professor Forbes "The Natural History of the European Seas," and the latter suggested to Mr. Austen to do "The Geological History of the European Area." Professor Henfrey's book appeared in 1852, and that by Professor Forbes was announced for 1853. With the work and engagements then pressing heavily upon him, no one was surprized at its not appearing, and indeed it is probable his own additional studies and the further researches desirable might have made him wish for a little delay before he committed himself to any general views on the marine fauna of the European seas. In 1855, the life and labours of one of the most eminent naturalists our native land has ever produced were suddenly cut off, and the little book, half-finished, half-printed, of which a few more months of his sojourn amongst us would have sufficed for the perfecting, has passed over to his friend for completion.

Professor Henfrey, the author of the first of the series of "Outlines of the Natural History of Europe," too, has passed away from amongst us.

No one element of recent investigation has a greater bearing, or is likely to throw more light upon the ancient geographical and physical conditions and distribution of the ancient extinct creations of our planet than the results of those accurate dredgings of the sea-bottom, to which Edward Forbes himself gave so strong an impetus, and those notations of organic forms occurring within special zones of depth, and the limitations of special groups within certain geographical areas. The bearings of these results upon fossil organic remains is of the highest value, and this book places all that is known before us in a quiet, unostentatious, but powerful manner. It is in fact a book of reference, but with these exceptions to the almost universal character of books of that class, that it is small, condensed, and not voluminous, and that it is pleasantly readable. It begins with an introductory chapter in Forbes' own easy polished style, in which the general distribution of organic life into distinct botanical and zoological provinces of greater or less extent, according to their degree of limitation by physical or climatal conditions, is succinctly pointed out. These provinces are not so entirely distinct, each from its neighbour, but that some commingling of the characteristic life-forms take place in the boundary regions which infringe upon each other. These provinces, as understood in this work, are areas "within which there is evidence of the special manifestation of the Creative Power; that is to say, within which there have been called into being the originals, or protoplasts, of animals or plants."

The aborigines of these areas in the lapse of time, or through the altered geographical and physical conditions of our planet, may become mixed up with emigrants from other provinces, and even exceeded by them in numbers. The distinguishing, therefore, of the original types and the determination of the causes which have produced and directed the invasion, are among the problems which the investigator of the distribution of animated creatures has to endeavour to solve. In the investigation of the fauna or flora of a province "the diffusion of the individuals of the characteristic species is found to indicate that the manifestation of the creative energy has not been equal in all parts of the area, but that in some portion of it, that usually more or less central, the genesis of new beings has been more intensely exerted than elsewhere. Hence, to represent a province diagrammatically, we might colour a nebulous space, in which the intensity of the hue would be exhibited towards the centre, and become fainter and fainter towards the circumference." This feature of zoological and botanical provinces gives rise to the term "*centres of creation*," which Forbes and others have applied to them. Nowhere do we find a province repeated, or, in other words, "no species has been called forth originally in more areas than one. Similar species, to which the term representative is mutually applied, appear in areas distant from each other, but under the influence of similar physical conditions." The term *specific centre* has been employed to express the point upon which each species had its origin, and whence its individuals have spread and radiated. In the course of its diffusion, or during the lapse of time, a species may become extinguished in its original centre, and groups of individuals may thus become isolated at spots far distant from each other. Indeed, the true specific centre in some cases may be rightly placed in the rock-strata of the earth, involving the necessity of tracing the history of the species backward in time, and of investigating its connection with geological changes.

Provinces also, like species, must be traced back to their history and origin in past time; for palæontological research exhibits the phenomenon of provinces in time, as well as provinces in space. Species, moreover, have a centering in geological time as well as in geographical space, and *no species are repeated in time*, that is, there has been no recreation of any same specific form; while "the distribution of the individuals of fossil species also indicates their diffusion from some unique point of origin, and consequently goes to support the notion of the connection of these individuals through the relationship of descent, and the derivation of them all from an original protoplast."

The sea-board of Europe extends through four degrees of latitude and six of longitude, from within the Arctic Circle to the Pillars of Hercules, with a last and isolated portion constituting the north-west border of the Caspian Sea. Along such a range of shore, extending through various climates, from the warm and sunny confines of Africa to the ice-bound cliffs of Nova Zembla and Spitzbergen, there are many and diversified assemblages of animated creatures. Those which "delight in the chilly waters of the Arctic Ocean must be very different from those which revel in the genial seas of the south; whilst the temperate tides that lave our own favoured shores cherish a submarine population intermediate in character between both." Thus, chiefly by the labours of Forbes, the European sea-area has been divided into six zoological provinces, within which he considered there were to be reckoned as many distinct centres of creation. The first and northernmost being the Arctic, "extending throughout that portion of the European seas within the Arctic Circle. The second, the Boreal "including the seas which wash the shores of Norway, Iceland, the Faroe, and the Zetland Isles. The third, the Celtic, "in which rank the British seas, the Baltic, and the shores of the continent from Bohuslan to the Bay of Biscay." The fourth, the Lusitanian, includes the Atlantic coasts of the Peninsula. The fifth, the Mediterranean, includes also the Black-sea; and lastly, the Caspian, a region now completely isolated from all the others. All these provinces are succinctly but perfectly, as far as existing knowledge goes, considered in their geographical, physical, and geological relations, and the characteristic life-forms of each carefully made out. Of these it was suggested, however, by Forbes that the Mediterranean and its dependencies may possibly be a chain of offsets from the Lusitanian area; while Mr. Austen seems to consider the Boreal fauna as a modification of the Arctic. In the chapter on the geographical distribution of shells in Mr. Woodward's "Manual of Mollusca," the lists of shells occurring in the several marine regions are tabulated, and these lists will be found to be useful companions to this "History of the European Seas." In the ninth chapter "On the Distribution of Marine Animals," amongst other interesting topics, that of those "outliers," or remarkable assemblages at spots, often far distant from the present boundaries of a province, of animals of its characteristic species, is treated very forcibly in its geological aspect. Such assemblages, for example, often occur within our own Celtic province, and are so peculiar and so isolated that they can not be accounted for by any facts connected with the present disposition of currents, or other transporting influences. They are "usually located in a hole or valley of considerable depth, from eighty to beyond one hundred fathoms, and consist of species of molluscs of a more northern character than those of the zone or province in which they occur."

"The explanation which Edward Forbes gives of these 'outliers' is as follows:—When the bed of the sea of that period, when in our latitudes the fauna was more northern than it is now, was upheaved, the whole was not raised into dry land, but tracts of greater depth, and which consequently were tenanted by peculiar forms, still remained under water, though under different depths. In these changes a portion of a fauna would be destroyed, but such species as could endure alterations in vertical range would live on."

Of such outliers, or isolated groups of fossil remains, Mr. Austen quotes the remarkable instance, noticed by M. Barrande, of a patch in one of the lower divisions of the great Palæozoic series of Bohemia, of as many as sixty species of forms not agreeing with those characterizing the horizon in which they occur. These forms are surmounted by beds containing the characteristic species of the same lower division, but the sixty species thus isolated appear again as a component part of the fauna of the "upper division" of the same palæozoic series. Such isolated assemblages are regarded by Mr. Austen as true outliers, and "will serve to suggest curious and interesting geological inferences in the earlier history (both natural and physical) of the European area."

Of the antiquity of the fauna of the European seas, Mr. Austen writes: "The fauna of the European seas dates back its origin or first appearance to times which, on the scale of the geologist, follow next after the Nummulitic period (Eocene). So far as European seas are concerned, they do not contain a single species in common with the forms of the nummulitic group. The earliest records of the occupation of the Atlantic by any existing forms are certain old sea-beds which are scattered at intervals over some of the western departments of France, extending inland along the valley of the Loire, as far eastward as beyond Blois, to be met with in some of its branches northwards—an old arm of the Atlantic, with dimensions nearly equal to those of our English Channel, long since laid dry. These old sea-beds are the 'Faluns of Touraine.'"

Lower down to the south, from the Island of Oléron across to the Adour, was another great indent of the Atlantic—an eastern extension of the Bay of Biscay. Over this once depressed area there are sea-beds which contain an assemblage like that of the Touraine deposits, the *Faluns Jaunes* of Grateloup."

He further regards the fauna of the Atlantic as primarily composed of a northern and a southern element, and "It is to be remarked," he says, "that the northern constituents of our present Atlantic fauna are not met with in the older fauna of the Faluns, nor in the equivalent assemblages further south. Northern forms had not, at that time, extended into that part of the Atlantic which lies west and south of the British Islands. Their great migration southwards took place subsequently to those great physical changes which converted into dry land those portions of western France above referred to, and which changes were trifling in amount when compared with those of the same date in other parts of the Atlantic, and within the Mediterranean area. The physical change which liberated the northern fauna has been indicated on independent considerations. It has been shown that there is good evidence of the former continuity of a coast-line from the north of Greenland to the north of Lapland, and that, consequently, the Atlantic did not then communicate with the Arctic basin; it was only when this barrier was removed that a free passage south was opened out to Arctic forms."

With the exception of a limitation at its northern extremity, "the Atlantic is an old area of depression. There was an Atlantic Ocean for the nummulitic, cretaceous, and palæozoic periods, during each of which it had its distinct zones of distribution in latitude, as well as its corresponding provinces of representative forms on its opposite sides."

With other equally interesting topics and reflections, the remaining chapters conclude a book which, from its intrinsic value and moderate price, will doubtless meet with an extensive sale, and prove a useful foundation as well as an encouragement to further investigations by naturalists of the interesting subject to which it is devoted.

Dura Den: A Monograph of the Yellow Sandstone, and its remarkable Fossil Remains. By JOHN ANDERSON, D.D., F.G.S., F.P.S., &c. Edinburgh: Thomas Constable and Co. London: Hamilton, Adams and Co., 1859.

Fifeshire, the general contour of which, in its gentle and undulating outlines, partakes more of the aspect of the English downs than of the bolder and more rugged features of the Scottish mountain-tracts, forms the eastern portion of the great central coal-district of Scotland. The Ochils, a chain of trap-hills varying in the extent of their range from four hundred feet in height to nearly three thousand in Bencleugh and Dalmyatt, traverse its northern boundary, and with the short but elevated table-land of the Lomonds running through the central portion, separate the county into three well-defined subordinate regions corresponding to three equally-marked geological distinctions. From the Lomond-heights the view is spoken of as charming. "Overlooking the
le county, and the two noble rivers by which it is encompassed, with the
n Ocean to the East, the town of Stirling and the 'lofty Ben Lomond'
est, the rugged serrated outline of the Grampians to the north, and

the extensive plains of the Lothians, begirt by the Pentlands and Lammermuirs, the Bass and Berwick-Law to the south; the prospect from either summit may vie with any in the kingdom, presenting at once to the eye whatever is necessary in water, forest, and mountain to form the beautiful, the picturesque, or the grand." The palace of Falkland lies at the base of the East Lomond, and in the midst of the deep blue waters of Loch-leven stand the ruins of the keep in which the unfortunate Mary Stuart was imprisoned by her subjects. Towards the southern boundary of this county, near a tributary of the river Eden, between the well-known towns of Cupar and St. Andrews, is Dura Den, famous in geological circles for its "yellow sandstone," the beautiful fossil fish entombed in which have given celebrity to this locality in every quarter of the world. Most of the species peculiar to this "yellow sandstone" are figured in Agassiz' grand work the "Poissons Fossiles," and in that author's separate memoir on the fishes of the Old Red Sandstone *(Monographie des Poissons fossiles du Vieux Grès Rouge)*. The present monograph in a scientific point of view derives one of its chief values from the descriptions of the new piscine forms *Phaneropleuron Andersoni*,* and *Glyptolæmus Kinnairdi*, by Professor Huxley.

Of Dr. Anderson's own labours we may say that he has usefully compiled the observations of other geologists on the zoological and physical character of the Old Red sandstone, and that he has done full justice to the opinions of Murchison, Austen, and Page on the origin of that formation, bringing prominently forward Mr. Austen's ingenious speculations on its possible lacustrine origin. The inference of its marine character derives its strongest support from the enormous thickness of the conglomerates in Scotland and Hereford, for the fishes may well be freshwater, and their admixture or concurrence with marine forms in the Russian equivalent of this deposit may be due to a possible habit of their visiting the sea, like the sturgeon, at certain periods, or to their having lived so near the sea as to be swept down by floods.

But while wishing to favour and encourage this, as we always desire to do every monographic work, we can not help regretting that many errors of statement, as well as typal incorrectnesses, have been allowed to pass forth to the world.

Nothing is more essential to scientific books than absolute correctness, and in such a monagraph as this of Dura Den, we ought not to find Pterygotus spelt with an improper o (p. 23) for the proper y, Encrinites spoken of and described (p. 93) as corals (!). Nor should, an inverted illustration as that of the characteristic heterocercal tail (p. 39), be allowed to escape notice. Truths are easily distinguished by the learned from casual errors, but it is different with the not skilfully versed: to detect one error is suggestive to them of another, and they naturally argue if an author blunders in small things, he is not reliable for the more important; thus many a valuable treatise has been cast aside, and every author who does not heed such minor matters will ever be subject to the like neglect.

Associated as Dr. Anderson's name is with the early history, and the complimentary nomenclature of the fossil fish of Dura Den, to no one could we have looked more appropriately for an account of that highly interesting and beautiful locality; and appearing as this work did at the period of a great gathering of learned gentlemen (the British Association Meeting), patronized by applauding royalty, it must have proved a tempting *bijou* for the many visitors that the Den, from its proximity to the scene of scientific action, would have had on the late occasion, and whom we are sure received a thorough Scottish welcome and entertainment from its kind-hearted and hospitable author. The book also receives an additional charm in the pretty drawings of the typical, as well as handsome, *Holoptychius Andersoni*, by Lady Kinnaird—a name also interestingly associated with the fossil trophies of Dura Den.

---

* The term *Glypticus* was applied by Agassiz to some fragments of this fish: that author concurs in Professor Huxley's more descriptive generic name.

Remarks on the Geology of Cornwall and Devon. By Capt. CHARLES THOMAS, of Dolcoath Mine, Camborne.

In a country like England, where great wealth and political position is due in no small extent to the development of its mineral and industrial resources, it is always a matter of importance to observe how far science can be brought to aid in the furthering of these great material objects. Of course we all know the opinion of the "practical" man of the old school on this subject. Science, according to his views, was a sneaking kind of thing, well enough for a Frenchman or a German, but something quite beneath the "practical common sense" of a true born John Bull. In the army or navy, the farm or the mine, it was everywhere the same. The last twenty years, however, has a good deal changed this; science is now popular enough—indeed almost too popular, for while every one wants to know it, there are many who won't take the trouble of learning it, but, on the strength of a week's "cram," pretend or imagine they know all about it. Whatever may be its other virtues, a retiring diffidence is certainly not a characteristic of the nineteenth century.

But in the midst of all this progress—real and sound, as well as hasty, shallow, and superficial—there is one corner of our isle to which we can turn and see the good old reign of "practical common sense" unshaken and immoveable. In the royal county of Cornwall scientific innovation—if proposed to be applied to the working of its great metallic resources—would meet with pretty much the same feelings as M. Mazzini's doctrines—if proposed to be applied to the government of the state—might be expected to excite in the bosoms of the ruling powers of Naples. Here at least—alone we believe among all our industrial communities—not only will they not exert themselves to procure some scientific education, but when, by the munificence of a few gentlemen, it is brought home to their door, they literally won't have it. A true bred Cornish miner would as much abhor soiling his mind with scientific "theories," as a high cast Brahmin would of polluting his lips with the flesh of cow-beef. But it is only an act of justice to admit that while this is generally the case among the Cornish miners, there are yet some exceptions; there are some who really desire knowledge, although, from the circumstances that surround them there are only few who succeed in attaining it, and those few generally disconnect themselves socially from their class, which has become distasteful to them, and pass into another sphere. Of those who do seek earnestly after scientific knowledge, and yet wholly fail in attaining it, the author of the pamphlet, whose title we have put at the head of this notice, is an excellent type.

Captain Charles Thomas, of Dolcoath mine, is deservedly one of the most trusted and respected mining agents in Cornwall—A man of solid sense and respectability, he is above the petty and mean vanity of many of his class which induces them to assumes a pseudo-scientific knowledge for the purpose of attaining notoriety. As he honestly says himself, "I aim rather at being understood by miners than being scientific." Of a man like this, while we shall speak plainly of his erroneous notions, we need not say we entertain a hearty personal respect.

Before we go further, we shall say a few words on the subject of observation, and the impossibility of placing any reliance upon the alledged "facts" put forth by non-scientific persons. The following excellent observations in a recent number of the "Saturday Review" are so much to the purpose, that we cannot better express our own opinion than by quoting them.

"Liebig justly notices the excessive difficulty of really good observation. It is an art only acquired by long practice and culture. People speak of facts with a confidence which, to the philosopher, is quite amusing. He is as ready as they can be, even more so, to admit the validity of facts; but he is not so ready to admit that the observations they christen by that name are true facts. 'The man,' says Liebig, 'who only sees with his eyes an object before him has no claim to the title of an observer, which is reserved for him who takes notice of the different parts of the object, and sees the connection between the parts and the whole.' There are 'facts' to support every absurdity. No speculation was ever so baseless as not to have some 'facts' on which to rest. But 'many individuals overlook the half of an event through carelessness; another adds to what he observes the creation of his own imagination; whilst a third, who sees sufficiently distinctly the different parts of the whole, confounds together things which ought to be kept separate.'"

Returning now to Captain Thomas's pamphlet. On the whole we are extremely disappointed with it; and that at the end of fifty years' experience a naturally intelligent man has so little to communicate is the severest commentary on the whole system of which he is a representative. He of course tilts against the doctrine of the igneous origin of granite, elvan, and trap. Speaking of the former, to which he also refers as "primitive," "immoved," he says: "The ideas suggested by its structure, as well as by the lofty hills and unbroken plains formed out of it, are those of substantiality, firmness, immovability, just such as we might expect it to be coming fresh from the hands of its Creator; exhibiting in the mass no signs of disturbance by the elements, no rending, or upheavals by earthquakes, &c." And this, our readers must remember, of the Cornish granite, which is newer in age than the Carboniferous system, that is broken through by it.

But leaving aside mere general geology, let us see what Captain Thomas has to say on the subject of metalliferous veins. One of his best points—indeed, the only one worthy of much notice—is the distinction which he very forcibly draws between the different *structural* characteristics of the Cornish granite, and their bearing on the productiveness of the lodes. He classes this rock as *primitive* and *secondary*, which he thus defines, with their effects on metalliferous production. We quote at some length, because the point is an important one, and cannot be too clearly understood.

"Hitherto no profitable mine has been found for tin, lead, or copper in what I beg leave to distinguish by the term *primitive granite*. It is hard and compact, and may generally be cleaved in straight lines as we see it used for building-purposes. It is found in most of our high hills with projecting tops. It is commonly found, too, in the central parts of granite districts, even where there are no projecting tops, at no great depth below the surface.

"At the sides and flat bases of such hills, as well as in the hollows between high hills and the margins of granite districts, another kind of granite is commonly found, which I distinguish as *secondary granite*. Although varied in its structure and composition in different localities, the following are some characteristic features: fracture rough and irregular; very jointy; frequently containing hornblende and chlorite; is traversed by regularly formed elvan-courses, whilst portions of it, like ribs, project from the main body into the surrounding slate. Its localities are some of the outskirts of primitive granite districts; the hollows between high hills; the *base* of lofty peaks rising from the interior of such districts, and sometimes rising in such situations into small hills itself. . . . A narrow margin only of some granite districts is of this kind, although a thin layer of it sometimes overspreads pretty large portions of primitive granite. . . . A considerable portion of our profitable mining operations is carried on either in, or contiguous to, this secondary granite (never extending into what I denominate primitive). As the productive granite commonly occupies the *base* of lofty hills, and the margin of some extensive granite districts, so the bold prominences and unbroken central portions may be safely assumed to be essentially of a primitive character."

"No *tin* mine, yielding a profit, has hitherto been found except in secondary granite, or in very quartzose or micaceous clay-slate, connected or unconnected with elvan. . . . *Copper* ores are much more extensively diffused, and good mines of this metal have been found in secondary granite, compact clay-slate of various colours when granular and containing a large portion of felspar, and in greenstone. Lodes in dark coloured killas are most productive when above, passing through, or a little below elvan-courses. At much depth below the elvan they are seldom rich, unless another elvan-course, or granite be situated below it still.

"After many years' experience, and careful observations, made in all the mining-districts of Cornwall and Devon, I have come to the conclusion that the two kinds of granite which I have designated as primitive and secondary, differ as much, in many respects, as granite and elvan; that primitive granite contains no metallic ores of value; that tin ores are found nearest to it; and copper ores of value never in it, nor very near to it."

Merely taking exception to the words *primitive* and *secondary*, we otherwise fully recognize the truth and importance of Captain Thomas's classification, which is a highly important one, and most creditable to his powers of observation. The "secondary" granite is that decomposed and altered portion constituting the "contact edges" and "upper surfaces" of the main, compact, or "primitive" mass, which latter according to Prof. Cotta's hypothesis would be deprived of all metallic contents by its more slow cooling; while the former, or "secondary" portion, which may vary in width according to circumstances, is, with the sedimentary rocks in its neighbourhood, and their associated "porphyries," or "elvans," exactly where, according to the same hypothesis, we should expect to find the metals most abundant, and where, according to the testimony of Capt. Thomas, they are in fact found in the rich mines of Cornwall.

As our limits are exhausted, we shall only refer to one point more. Captain Thomas strongly objects to the hypothesis that metals are probably derived from beneath. The reason he gives for this objection is that the deepest granite is the most unproductive of metalliferous ores. "The Cornish and Devon mines of all kinds," he says, "are found in strata of different sorts, including patches of a certain kind of granite, lying upon the everlasting rock, the primitive, the unmoved granite—never in it." Leaving out of the question the mistaken notion which Captain Thomas seems still to hold of all granite being "primitive," whereas the Cornish granite is comparatively recent, the objection is not an unnatural one. But it is completely met by Prof. Cotta's hypothesis, as pointed out by Mr. Salmon in his article in our present number, to which we refer our readers.

We have spoken freely on the important subject of the complete want of scientific education among Cornish miners. It is a lamentable thing to see so much natural good sense, such great practical experience, and such unparalleled opportunities of observation, lying comparatively barren and unproductive to the progress of science; or, still worse, being often absolutely a bar to its advance, by lending itself to contemptible charlatanism.

Thos Robinson

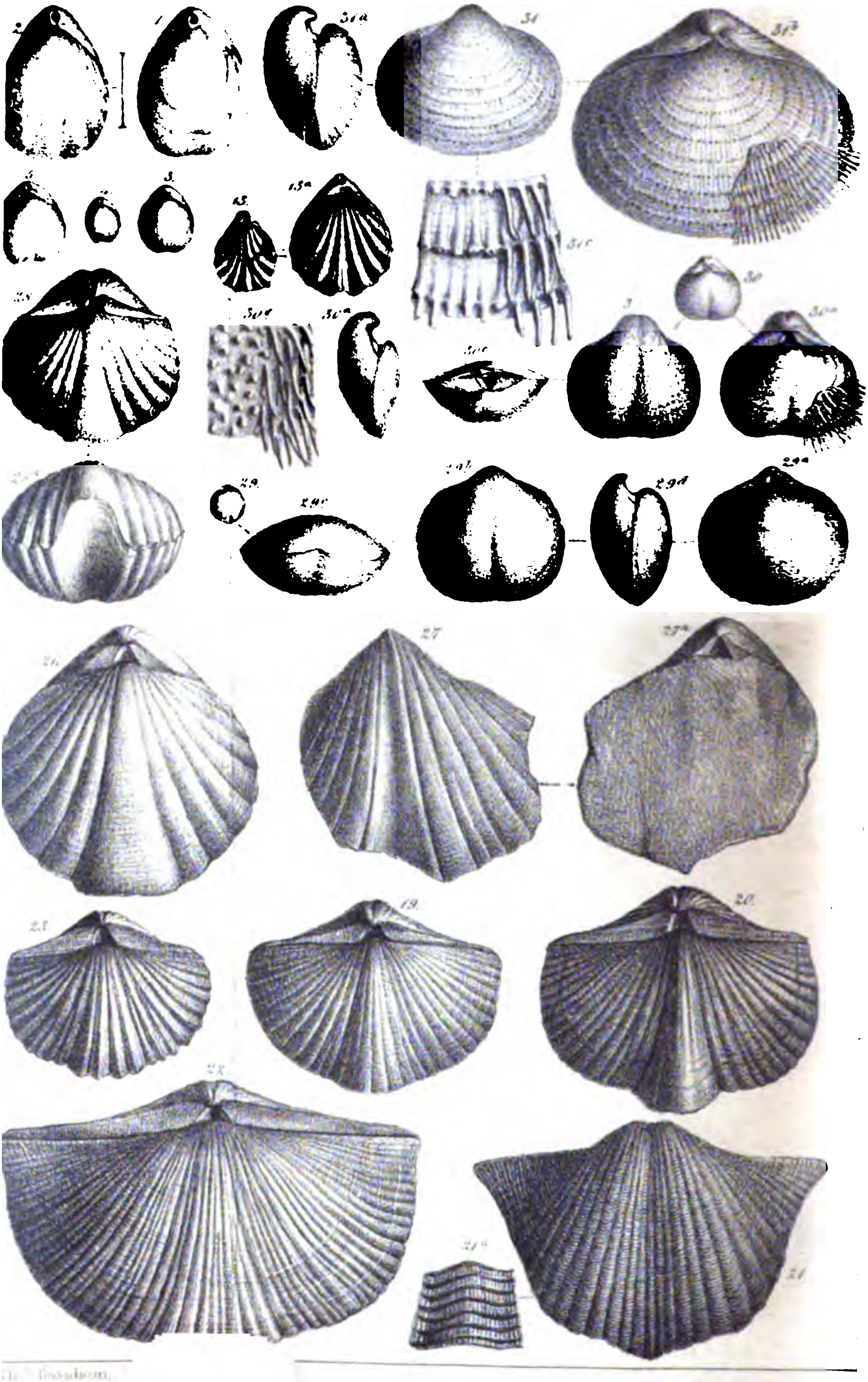
.C-

the

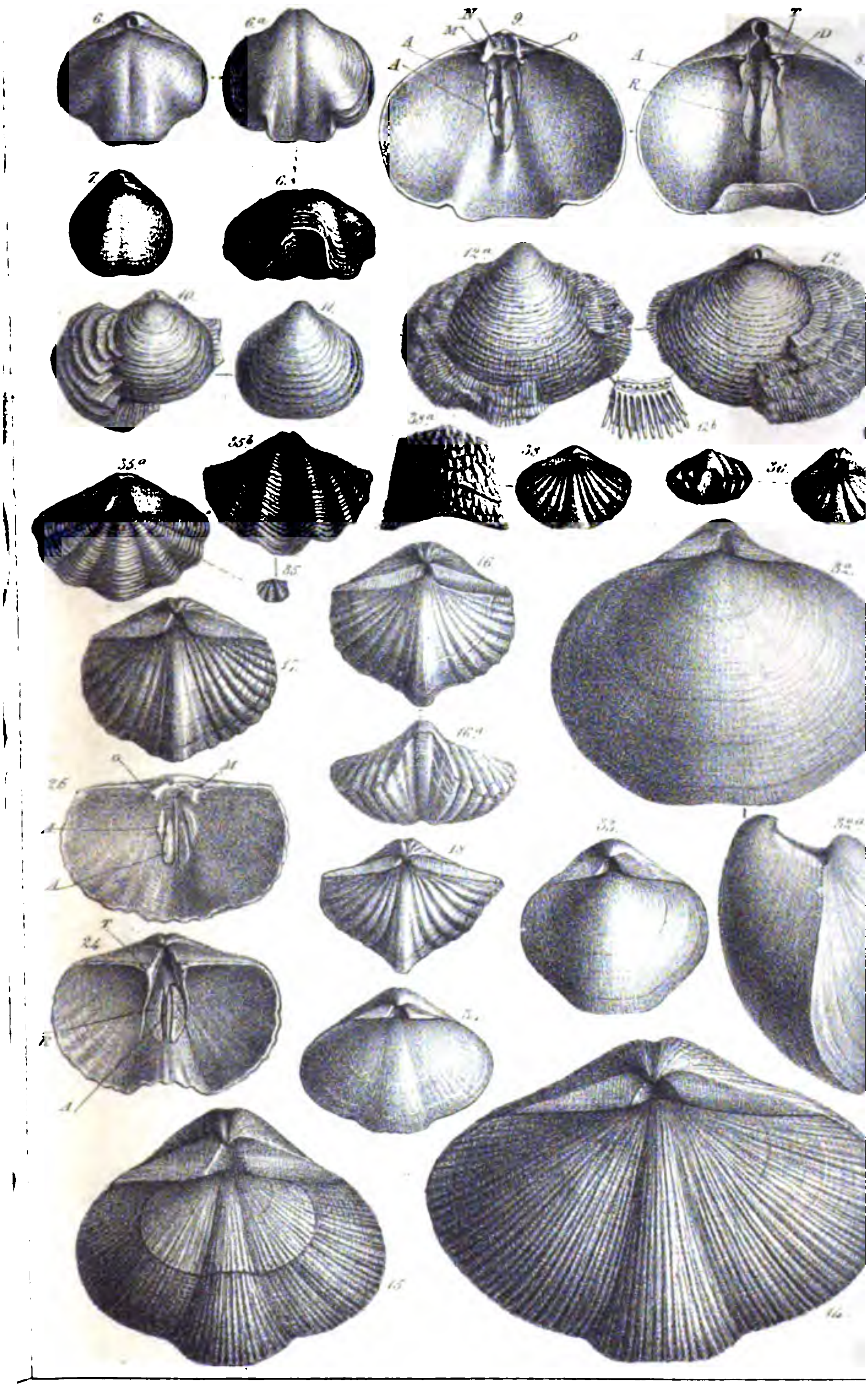
no
ers.
be
heir
tri-
lds

and
een
im-
cu-
lete
ich
re-
da-
ay,
dge
eat
st;
. P.
one
.
and
een
nty

bly
hys,
tc. ?
etc.,



Th.s Davidson.


6.
6a
7.
6.
N
9
M
A
A
O
T
D
8
A
R
10.
11.
12a
12.
12b
35a
35b
38a
38
36.
35
16.
17.
16a
32.
26
O
M
A
A
18
33.
32a
T
24
R
A
34
15
14

of.
op
(m
gr
tea
ma

gr
wi
m
va
gi
pa
th
si

m
tw
as
ta
pe

fu
wl
tic
st
"]
de
"
wi
pl
sh
te

Tl
be
th
of
of
u
n
ti
a
p
rc

s
m
lc
t
a,

THE GEOLOGIST.

DECEMBER, 1859.

THE CARBONIFEROUS SYSTEM IN SCOTLAND CHARACTERIZED BY ITS BRACHIOPODA.

By Thomas Davidson, Esq., F.R.S., F.G.S., Hon. Member of the Geological Society of Glasgow, etc., etc.

Much has been written on the geology of Scotland, and perhaps no country has given birth to a larger proportion of eminent inquirers. The names of Hutton, Playfair, Murchison, and Lyell will ever be remembered among those of the great Scotchmen, who by their acquirements, genius, and perseverance, have so materially contributed to elevate the science of Geology to the rank it now holds among all men of learning.

Much has, however, still to be achieved before the geological and palæontological details connected with our country will have been completely worked out, and many zealous inquirers must be summoned to the field; some will do much, others little; but every accurate observation is so much gain, and will tend towards the complete elucidation of the subject, as well as help to form a basis upon which great minds may found with safety their general views and appreciations. I therefore hailed with much hope and delight the foundation of a Geological Society in Glasgow, which originated in May, 1858, with about a dozen young men, who wished to gain knowledge of the geological phenomena in the neighbourhood of their great city, under the guidance of an experienced and practical geologist; and thus, owing to the active co-operation and direction of Mr. J. P. Fraser, and that of some of its founders, the Society has already done some good work, and increased its numbers to about one hundred.

Scotland was long believed to be poor in organic remains, and although many are the remarkable fossil organisms that have been made known from time to time,* it is only within the last twenty years or so that much attention has been devoted to the subject, and the palæontological riches of some of its rocks have been duly appreciated. It is, therefore, chiefly at the suggestion of my much esteemed friend Mr. John Young, of the Hunterian Museum of Glasgow, that I here attempt the publication of a special illustrated catalogue, or monograph, of all the Scottish species of Brachiopoda that have been hitherto obtained from the strata of the Carboniferous period; and this I have undertaken in the hope that by so doing it may stimulate and facilitate further researches, as well as prove of some assistance to those friends in Scotland to whom I am personally indebted for the gift and loan of the valuable series of specimens which will be made use of in the present memoir.*

---

* Who is unacquainted with the wonderous fishes discovered and so admirably described by Agassiz, H. Miller, Egerton, and others, such as the *Pterichthys*, *Coccosteus*, *Dipterus*, *Cephalaspis*, *Holoptychius*, *Megalichthys*, *Asterolepis*, etc.? Have not the *Telerpeton Elginense*, the *Stagonolepis*, the *Pterygotus bilobus*, etc.,

Almost all the great geological systems are represented in Scotland, although not generally so completely as may be seen in other countries. Many of our principal fossiliferous deposits are to be found in the Carboniferous system, and especially so as far as the Brachiopoda are concerned. It will, therefore, be a subject for present and future research to determine as nearly as possible the exact horizon or vertical distribution of the species, or, in other words, of their individual duration in time and space; but prior to entering upon this and other palæontological questions which will form the main purport of the present communication, it will be desirable to preface the subject by a few lines upon the strata themselves, that the

---

been recent and startling discoveries? Does not the rich and varied collection of Scottish fossils, formed with so much skill and science by the lamented H. Miller, as well as that of Dr. Fleming, and many others, show how much palæontological wealth we already possess, and may still expect to discover.

Unfortunately, but a small proportion of our species have been hitherto made known, and it is to be hoped and much desired that some day the palæontology of Scotland will be separately and specially treated—an object the late Professor Edward Forbes had always in view, and which, had he lived, was his firm resolution to have accomplished.

* For some years past, I have been accumulating material and observations on Scottish Brachiopoda, on account of the monographs which are being published by the Palæontographical Society of London; and, although my own field-researches in Scotland have been very limited in their extent, I may, perhaps, be permitted to mention that I devoted with but little intermission the larger portion of the years 1835 and 1836 towards assisting my late friend Robert J. Hay Cunningham, while preparing his prize-essay "On the Geology of the Lothians," which counties were traversed by us in almost every direction. I have also had the advantage of being able to visit some portions of the Lanarkshire and Fifeshire coal-fields.

It is to me a very pleasing duty to acknowledge the important, truly kind, and zealous assistance I have received from many of my countryman, while collecting material in connection with this paper, and I therefore beg to tender my warmest thanks to Sir R. Murchison, Mr. John Young, Mr. J. Armstrong, Mr. Page, Mr. J. P. Fraser, Mr. J. Thomson, Mr. A. Bryson, Mr. Rose, Mr. A. Cowan, Mr. J. Bennie, Dr. Slimon, Professor Nicol, Mr. Smith, Mrs. Rogers, as well as to the memory of the late Dr. Fleming and H. Miller.

I have also had access to a very extensive and valuable collection of specimens derived from the parish of Carluke, made many years ago by a local inquirer, to whom I am indebted for much kindness, as well as for the specimens I am able to figure, and the information I shall communicate on that important district.

general reader may better understand the position in the series occupied by the species to be hereafter described.

It is well known to every one possessing a knowledge of the first rudiments of geology, that the Carboniferous system lies between the Devonian and Permian formations; but we cannot expect always and everywhere to find the sequence complete. Instances are not wanting wherein Carboniferous strata repose directly upon Silurian or older rocks, and are overlaid by Jurassic or still younger deposits; but in such cases, which are likewise common to formations of all ages or periods, the natural order of succession does not exist, for the strata which should underlie or overlie in natural order are wanting from some cause or another.

The rocks which compose the Carboniferous series are not everywhere exactly similar; for in some districts a certain bed, or series of beds, may be largely developed, while they may be attenuated, or entirely absent, in another. The Carboniferous system is made up of a vast accumulation of conglomerates, sandstones, shales, ironstones, limestones, and coal-seams, and certain portions of the system present a marine, others an estuary character, while a third is entirely composed of terrestrial vegetation; and, as stated by Mr. Page, in his excellent text-book, " the frequent alternations of strata, and the great extent of our coal-fields, indicate the existence of vast estuaries and inland seas, of gigantic rivers and periodical inundations, while the mountain-limestone, with its marine remains, reminds us of low tropical islands fringed with coral-reefs, and lagoons thronged with shell-fish and fishes."

Before alluding to the divisions that have been proposed for the Carboniferous system, we must briefly notice that, although Sir R. Murchison and the generality of geologists have pronounced the Old Red sandstone of Scotland* to be the full equivalent in time of the Devonian rocks of other countries, some geologists, such as Professor de Koninck and Mr. Kelly, have suggested that these red sandstones, especially in the southern portion of Scotland, and in Ireland, should be considered as forming part of the Carboniferous series. Be this as it may, the celebrated author of the " Silurian System " has himself admitted that, " as we approach the summit or higher beds of the Devonian or Old Red sandstone, we are gradually introduced to the fauna of the Carboniferous era." Therefore the passage between the upper beds of the Old Red sandstone and the lower one of the Carboniferous system has been gradual; while the same may be said relative to that which connects the upper beds of the Carboniferous with the lower ones of the Permian formations. Some geologists would, therefore, place the basement-line of the Carboniferous system lower down than others appear disposed to admit; and hence the difference in opinion that may be traced in the various sections or groupings of the Carboniferous deposits that have from time to time made their appearance in different works.

---

* The rock is not everywhere of a red colour, there being also enormous beds of yellow, whitish, purplish, and rusty-coloured sandstone, with coarse conglomerates, and dark-grey micaceous flagstones.

In the valley of the Leven and Strath Endrick the one formation passes gradually into the other without any seeming change in the angle of dip, so that it is scarcely possible to draw a line between the two systems; and it is well known that the late Professor Fleming has often expressed a similar opinion.

It is not, however, the object of the present paper to discuss any geological questions, and far less the age or affinities of the Old Red sandstone; but we will conclude the little we have thought necessary to mention by a short extract taken from the last edition of "Siluria," wherein the author has stated that "the Old Red sandstone in Lanarkshire is of comparatively small dimensions, from the great masses of rock which constitute the central and superior members of the group in the north-east of Scotland being there omitted, and that it has not afforded any characteristic organic remains; that it is only in certain reddish and yellowish sandstones and shales, as seen in Fifeshire, the Lothians, and particularly in Ayrshire, that the geologist can be said to enter among those strata which here and there are linked on the Carboniferous rocks above, as they unquestionably are to the Old Red sandstone below, and which, according to the predominence of their fossil contents, may be grouped with either deposit, like the tilestones which connect the Upper Silurian with the true transition-beds which unite the Old Red with the Carboniferous series."

No Brachiopoda have been found in these Old Red sandstone beds of Scotland.*

For general and detailed information concerning the geology of the Carboniferous systems we must refer the reader to the well-known works of Sir R. Murchison, Professor Phillips, General Portlock, Sir R. Griffith, Mr. Kelly, and of many other geologists; it being sufficient for our present purpose to notice that, although the system has been somewhat differently subdivided in England, Scotland, and Ireland, geologists are of opinion that it is susceptible of being advantageously arranged into three well-marked groups, viz., the "Lower Coal-measures," the "Mountain- or Carboniferous-limestone," and the "Upper or True Coal-measures."

---

* Down the river Kildress, in Ireland, General Portlock and Mr. Kelly have shown that under the calciferous or calcareous slates there occurs extensive alternations of yellowish and reddish sandstones, then a bed of limestone, and still lower down another band of red sandstone, replete with the most common fossils of the carboniferous period, such as *Athyris ambigua*, *Spiriferina octoplicata*, *Rhynchonella pleurodon*, *Streptorhynchus crenistria*, etc. Irish geologists have rightly considered these strata as constituting the lowest division of the Carboniferous system, and they would be there in all probability some of the equivalents of those strata which Sir R. Murchison has mentioned as occurring in Fifeshire and in Ayrshire, and which he considers to form the transition-beds between the Carboniferous and Old Red systems; but with this difference, that in Ireland the red and yellow sandstones are full of fossils, while none appear to have been hitherto discovered in the corresponding Scottish strata, although the same species have been found higher up in the system. It is, therefore, questionable whether Irish geologists are justified while applying to this lower red and yellow division of the Carboniferous series the appellation of "Old Red sandstone," in making it a plea for annulling the Devonian system in toto.

In England a fourth division is sometimes introduced, viz., the "Millstone-grit," which is situated between the Mountain-limestone and the Coal-measures, but which, according to Professor Phillips, would form a kind of transition group, which may sometimes for convenience be joined to the lower, sometimes to the upper, and occasionally be treated alone.

In Ireland the system has been differently divided; but Mr. Kelly is of opinion that it may be arranged into—1st, "Lower Coal-measures" (comprising the Kildress red and yellow sandstones, and still higher calciferous slates); 2ndly, the "Carboniferous-limestone;" and 3rdly, the "Coal-measures." But it is chiefly the first, or lower, division that predominates, and which has induced Professor Phillips to assimilate the Irish carboniferous series to the great English and Welsh groups.

In England (according to the same distinguished authority) the Carboniferous system, when in its most complete development, would admit of the following groups, but which are not to be found together in every district:

1. Upper Coal-measures	*a* Coal-measures. *b* Millstone-grit.
2. Mountain or Carboniferous-limestone	*c* Yoredale Rocks. *d* Scar Limestone.
3. Lower Coal-measures	*e* Shales.

Having thus briefly alluded to the divisions in England and in Ireland, we may at once mention that in Scotland the three groups are likewise represented.

It has been calculated by Professor Nicol that the carboniferous strata cover nearly a seventeenth of the surface of Scotland; but it is very difficult to form a correct estimate, on account of the numerous breaks from intrusive igneous rocks rendering mapping very complex. It is, however, in the central portion of Scotland that the rocks which we are now describing occupy the greatest surface; they form there a wide sub-parallel band of nearly one hundred miles in length, by some fifty in breadth, extending from the northern portion of the Frith of Forth to the Clyde, and as far as the extremity of Cantire. No portion of the system appears to have been discovered in the north; but in the south there exists a narrow band, or separate patches, which extend along the frontiers of Scotland and England, from Berwick to near Kircudbright, on the Solway Frith.

Scottish carboniferous deposits differ, however, from strata of a similar age, existing both in England and Ireland, in the manner in which the various beds of encrinal- and coralline-limestones are intercalated with coal-beds and bituminous schists in the lower parts of the system.

In no single locality do we find a section in which all the beds occur in regular and uninterrupted succession; the absence of some, or the thinning-out of others, constitute local differences which should always be expected and duly considered. Thus, in Lanarkshire generally, as well as in other parts of the Clydesdale coal-field, the strata composing the Carboniferous system have been divided into four principal groups; and I am indebted to a friend in Carluke for the section here given, and which we will describe in the descending order.

I. The UPPER COAL-SERIES, measuring in some localities about one hundred and fifty-nine fathoms. It consists of eleven seams of workable coal and numerous smaller seams (among which we may name that which has been designated as the "Ell coal," and which is situated towards the top of the group), of sandstones, for the most part white in colour, or white with dark streaks, of fire clay and shales, a bed of freshwater limestone, and a few important bands of ironstone.	Horizon of the "Ell Coal" (In this column are enumerated the fossiliferous strata wherein Brachiopoda have been found in the parish of Carluke, and which will be hereafter referred to when we treat of the species. The position is given at so many fathoms below the horizon of the "Ell Coal," but it would be quite as easy to take the space from the horizon of the "Productus giganteus limestone" upwards.)	
II. The UPPER LIMESTONE-SERIES, about one hundred and twenty-five fathoms in thickness, consisting of three limestone beds, but no workable coal, although there are several thin seams, several bands of ironstone, occasionally gritty—and in the lower part sandstone of a yellow colour, fire clay, and shales.	Slaty-ironstone, Thomson's Balls Gare limestone Belston Burn limestone. Belston-limestone	160 fathoms. below Ell Coal. 173 „ 239 „ 265 „ 283 „
III. The LOWER COAL-MEASURES, about thirty-seven fathoms in thickness—consisting of four workable seams, the undermost being the "cannel"- or "gas-seam," so well known, and several other smaller seams; sandstones white and sometimes yellow; fire-clay, shale, & a few ironstone bands.	Maggy ironstones	300 „

IV. The LOWER LIMESTONE-SERIES, about one hundred fathoms in thickness, consists of nine or ten beds of limestone; coal-seams of poor quality accompanying, or rather lying under, the last three; yellow and white sandstone, rather sparingly developed; vast beds of shales becoming red towards the base of the series; fire-clay, red in colour in the lower beds; numerous bands of ironstone—resting on the OLD RED SANDSTONE.	Lingula-ironstone	317	fathoms.
	Lingula-limestone	337	„
	1st Kingshaw limestone	338	„
	2nd Kingshaw limestone.	341	„
	1st. Calmy limestone.	343	„
	Raes Gill ironstone	354	„
	Hosie's limestone	356	„
	2nd Calmy limestone	371	„
	Main limestone	375	„
	Shelly limestone	391	„
	Great *Productus* (*giganteus*) limestone.	397	„
	Ironstone-bed, *Productus punctatus*	400	„

In all but the upper coal-series have Brachiopoda been found; they appear, however, more numerous in the second and fourth divisions.

No regular section or detailed account of the coal-formation to the north of Glasgow appears to exist, yet it is evident from the position of the strata, and the similarity of the fossils found in the beds, that they also occupy the same stratigraphical position, as in the Carluke section, but with this important and notable difference, namely, that the lower marine limestones and shales containing fossils in the parish of Carluke come very close upon the Old Red sandstone, without any thickness of strata intervening; and this seems also to be the case all along the south-western border of the coal-field, while all along the north-western border the lower marine limestone and shales are separated from the Old Red sandstone by an immense deposit made up of numerous alternations of thin-bedded limestones and marly shales, with one or two beds of red and grey micaceous sandstones, locally termed "Ballagan-" and "Levenside-limestones," from the fine sections of strata exposed at those places.* These beds had formerly been regarded by some geologists as belonging to the uppermost member of the Old Red sandstone, while others referred them to the Lower Carboniferous; and it was only recently, from Mr. Young having in three different localities found fossils of a true carboniferous type, that these doubtful beds, upwards of one thousand feet in thickness, could be referred with some degree of certainty to the Carboniferous system, and of which they will be found to constitute some of the lowest members in Scotland. No Brachiopoda or other shells have, however, been hitherto discovered in these rocks; and Mr. Young is acquainted with no other place where an equivalent to these beds has been found but in the Merse of Berwickshire to the south-east of Scotland, where they present the same thin-bedded character, and hold the same relation to the Old Red sandstone and overlying coal-measures which they do to the north of Glasgow. Above these beds in the valley of Campsie, there occurs a series of thin-bedded strata, which appear to Mr. Young to be a continuation of the Ballagan series, over which a thick-bedded sandstone forms the floor of the valley, and contains numerous casts of plants, &c. In the immediate neighbourhood of Lennoxtown, a group of marine limestones and clay-ironstone, with intercalated beds of freshwater strata, containing cypridæ and remains of fishes, is seen cropping out at the base of the north and south hills; they all underlie the main coal and limestone, and seem to be the equivalent of the lowest fossiliferous beds of the Carluke district. Above these beds, in the district under description, occurs the Campsie main coal and limestone, with their accompanying alum-shales and freshwater limestone; these beds being the equivalents of the Carluke main coal and limestone, and twenty-two fathoms above this are found a bed of marine limestone and shales with clay-ironstone bands, which may perhaps be considered on the same horizon with the "Hosie's" limestone in the Carluke-parish section. At four miles east of Campsie, on the north Hill, we come upon the very interesting section of Corrie Burn, which Mr. Young has worked out with so much attention, and which consists of thick-bedded calcareous shales, coralline and encrinal-limestones, yellow sandstone, and numerous bands of clay-ironstone, which form the higher members of the series, the organic remains being very abundant in the strata, and of mountain-limestone types; while the strata itself is the best exemplification we have of that group`in this part of the country. It partakes of the same dip as the beds in the valley of Campsie, viz., to the south-east, and may be regarded as belonging to the higher members of the lower marine series. In conclusion, we will append Mr. Young's lists of the various strata from which Brachiopoda have been derived to the north of Glasgow and valley of Campsie, as far as possible, showing the descending order of the series:

---

* I am indebted to Mr. John Young for the information I possess relative to the strata to the north of Glasgow; and to Messrs. Thomson and Armstrong for that relative to Ayrshire and the neighbourhood of Glasgow. I attach much importance to these districts on account of the great care with which the Brachiopoda have been collected, and of which we will furnish complete lists hereafter.

Top, 1. Robroyston beds, near Glasgow: limestone and shales.
2. Bishopbriggs beds, near Glasgow: limestone (impure) and shales.
3. Limestone (culmy), Moodies-burn; six miles south-east of Campsie.
4. Corrie Burn beds: sandstone, limestone, ironstone, and shales; four miles east of Campsie.
5 Balquarhage beds: limestone (culmy), shales, with ironstone; two miles south of Campsie.

6. Black limestone (impure) and shales; South-hill, Campsie.
7. Main limestone, shale, and ironstone; Campsie.
8. Balgrochan Burn beds: shelly limestone, and shales; North-hill, Campsie.
9. Mill Burn beds: limestone, ironstone, and shales; Campsie.
10. Balglass Burn beds: ironstone and shales; Campsie.
11. Craigenglen beds: limestone (impure), ironstone, and shales; two miles south-west of Campsie
12. Beds in the valley of Campsie, consisting of thin-bedded strata known only by boring.
13. Ballagan beds: great thickness of thin-bedded nodular limestone, marly shale, and red and grey micaceous sandstone; north and west of Campsie.
14. OLD RED SANDSTONE, of a brick-red colour, and of great thickness: has hitherto yielded no fossils.

The marine limestone and shale extend from Corrieburn to the Craigenglen beds, and belong to the lower marine limestone formation of Scotland. In the valley of Campsie the upper marine limestone is wanting.

In Ayrshire, Arran, and Bute we find, with small local differences, much of the same order of succession, and most of the fossils that have been collected in Lanarkshire, Renfrewshire, Dumbartonshire, and Stirlingshire. Near Dunbar, in Haddingtonshire, we again find similar shales and limestones replete with fossils identical with those which abound in the parishes of Carluke, Kilbride, at Campsie, Lesmahago, &c. And any one would at once conclude that all represent the same geological epoch.

In the Lothians, as well as in Fife, the Lower Coal-measures are stated by Mr. Page to have "none of the shaly character, but to consist of thick-bedded sandstones, dark bituminous slates, bands of ironstone, thin seams of coal, and peculiar strata either of shell-limestone, or of argillaceous limestone, thought, from the fossils, to be of fresh-water or estuary origin; . . . . and that the lower group, as developed in Scotland, differs little in appearance from the upper group: hence the term 'Lower Coal-measures' generally applied to it in that country." In these counties the Brachiopoda are not so abundantly distributed as in the Clydesdale basin; still the species that have been collected at such places as Dryden, Courland, and Scola Burn, near Edinburgh, as well as in other more distant localities, do not differ specifically from those found in the other counties above referred to.

We will here conclude the very few stratigraphical observations we have thought necessary to introduce, and devote the remainder of our paper to the description of the species of Brachiopoda that have been hitherto discovered; and, although the series is numerically less complete than that of England and Ireland, it is probable that the catalogue may be somewhat increased by further research.

It is to the deservedly honoured name of the son of a working weaver in Glasgow that science is indebted for the first account of a not inconsiderable number of the natural riches of one of the most productive coal-fields in Scotland. David Ure, while unemployed at his loom, was continually observing and collecting all that appeared to him worthy of notice; and in 1793 he published a very remarkable octavo volume, entitled "The History of Rutherglen and East Kilbride," and in which will be found the first descriptions and figures of about eleven of the most characteristic Carboniferous brachiopoda that occur in the neighbourhood of Glasgow. David Ure was acquainted with Fabius Columna's "De Purpura," published in 1616, and adopted his term "anomia" for the greater number of those shells which we now include among the Brachiopoda. In 1793, and for nearly half a century later, so little was known of the true character of the numerous shells that compose the class, that it would be unreasonable to expect that Ure, with all that superior mind with which he was endowed, could do more than endeavour to class his shells according to what might appear to him their external resemblances. He therefore arranged his specimens into three sections, viz.: 1. *Anomiæ læves;* 2. *A. striatæ;* 3. *A. echinatæ.* No specific denominations were however given; but in order to convey to the reader a better idea of the author's views, we may mention that in his "Anomiæ læves" were placed those species that were afterwards termed *Athyris ambigua* (Ure, pl. xvi. fig 9), and *Spirifera Urii* (pl. xiv. fig 12). In his "Anomiæ striatæ" we find *Rhynchonella pleurodon* (pl. xiv. fig 6), *Spirifera bisulcata* (pl. xv. fig 1), and *Orthis Michelini* (pl. xiv. figs 13, 14); while his "Anomiæ echinatæ" would comprise *Productus longispinus* (pl. xv. figs 3, 4), *Prod. semireticulatus* (pl. xvi. fig 12), and *Prod. punctatus* (pl. xv. fig 7). Under the genus "Pecten," he further adds, *Chonetes variolata* (pl. xvi. figs 10, 11), *Streptorhynchus crenistria* (pl. xiv. fig 19), and *St. radialis* (pl. xvi. fig 13). Under "Patella" he figures a *Discina* (pl. xv. fig 10). Such an arrangement of the Brachiopoda would now-a-days appear impossible, but in 1793 it was perfectly unavoidable, as well as excusable. Ure's figures are very passable, and especially so for the time at which they were engraved. The author appears also to have appreciated the importance of internal characters; but, from not being able to interpret the value or use of the impressions, &c., he did not always represent them correctly.*

But few of our Scottish Brachiopoda have been figured or properly described since the time of Ure, so that the present contribution will, I hope, really fill up a deficiency. In his "History of British Animals," published in 1828, Dr. Fleming does not make much allusion to Scottish species, but he now and then refers to a few of Ure's figures, and in particular to pl. xiv. fig 12, to which he applies the denomination of *Spirifer Urii.*

---

* David Ure was for some time engaged on Sir John Sinclair's Statistical Account of Scotland, and was ultimately a minister of the church of Scotland.

In the "Mineral Conchology" six or seven species or varieties of Scottish Producti were figured and described by James Sowerby and his son, from specimens communicated by the late Dr. Fleming; thus, *Productus longispinus*, *P. Flemingii*, *P. spinulosa*, *P. Scoticus*, and *P. spinosus*, were published in 1814; *P. lobatus* (from Arran) in 1821; *P. costata* (from near Glasgow) in 1827; and *Leptæna distorta* 1840.

In a few books and papers we find lists of some Scottish brachiopoda; but these I have found from experience not always to be depended upon. We may, however, notice that, in his "Geology of Clydesdale and Arran," Dr. Bryce mentions seventeen species found by Professor Ramsay in Arran, and seven in Bute by Mr. Fraser.

Some of the same species have been alluded to by Professors M'Coy and Morris; but, with the exception of those figured by Ure, Sowerby, and myself ("Monograph of British Carboniferous Brachiopoda"), I am not acquainted with any other illustrations of our Scottish carboniferous brachiopoda.

The only other general observation to which we will at present refer, is, that Professor de Koninck believes that he has succeeded in tracing in the Carboniferous formations of England and Scotland, two great different faunas; the one corresponding to the carboniferous fauna of Visé and Bleidberg, the other to the fauna of the Tournay coal-basin (in Belgium). These two faunas, although contemporaneous, are said to be nowhere found co-existent. After many endeavours to solve the enigma by means of direct stratigraphical observations at Visé and at Tournay, the distinguished Belgian palæontologist does not appear to have been able to arrive at any further solution than that the generality of species were different in both localities. I confess myself unable to discuss the matter in question, and must wait for the promised development of the author's views; and I content myself by observing, that the species found in the Scottish carboniferous deposits are attributed by Professor de Koninck to his fauna of Visé.

SCOTTISH CARBONIFEROUS BRACHIOPODA.

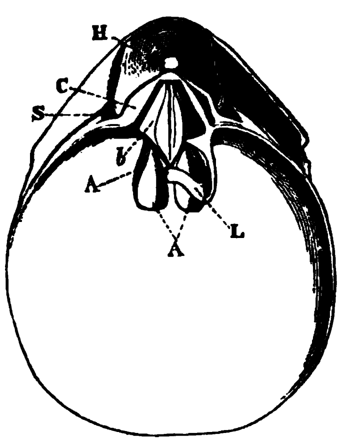
FAMILY TEREBRATULIDÆ.

Genus *Terebratula* Llhwyd, 1699.*

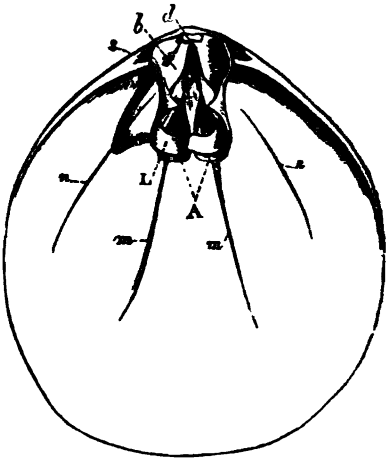
As we have already had occasion to observe, in our monograph published by the Palæontographical Society, the species belonging to this genus were not specifically numerous during the Carboniferous period, and, as far as our observations will conduct us, were characterized by the presence of short simple loops, as may be seen in lignograph fig 1.

---

* I must refer the reader to the English, French, and German editions of my "General Introduction" for full particulars relative to the families and genera of Brachiopoda.



Lign 1.—Terebratula elongata (Permian). Interior of dorsal valve, with part of the ventral one.
H, Rostral or dental plates of ventral valve.
S, Sockets of dorsal valve.
c, *b*, Hinge-plates.
L, Loop.
A, Quadruple impression of the adductor muscle.



Lign. 2.—Terebratula vitrea (recent). Interior of dorsal valve.
d, Cardinal process.
b, Hinge-plate.
s, Dental sockets.
L, Loop.
A, Quadruple impression of the adductor, or anterior and posterior occlusor muscle.

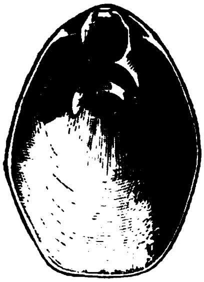
The family Terebratulidæ comprises many genera and sub-genera; but these do not all appear to possess an equal value or importance, and time alone will decide how far we are justified in certain of the divisions that have been proposed. Professors M'Coy and King are of opinion that Palæozoic Terebratulæ such as *T. hastata*, *T. sacculus*, and *T. vesicularis*, should be separated from *Terebratula* proper (such as *T. vitrea*, *T. carnea*, and *T. biplicata)* on account of certain peculiarities, or differences, and have respectively proposed *Seminula* and *Epithyris*, Phillips, as generic denominations for their reception.

The differences between *Terebratula* proper and the palæozoic species above-mentioned are chiefly confined to the presence of prominent dental or rostral plates in the one, and their almost total absence in the other, as well as in certain details connected with the hinge-plate. On the other hand, the exterior characters are similar; and in the interior, the loop offers the same dispositions—is short and simply attached, the longitudinal branches being united by a transversal band more or less bent up in the middle, as is seen in Lign. 2. The muscular impressions are also similar, as well as the intimate shell-structure. Therefore, while provisionally locating the Carboniferous species under *Terebratula*, it will be necessary to bear in mind those small differences observable in the rostral cavity of the beak and hinge-plate which appear to distinguish the Palæozoic from the Mesozoic species.

I.—Terebratula hastata. Sowerby. Pl. xii., figs. 1, 2.

Terebratula hastata, J. de C. Sowerby, Min. Con. Tab. 446, fig. 1-3, 1824, and Dav. Mon. Carb., p. 11, pl. i., figs. 1-12.

The shell is usually elongated, oval, or obscurely pentagonal, rounded or truncated in front, and tapering at the back. The valves are convex, and almost equally deep, with a wide mesial depression towards the front in the larger number of individuals. The beak is moderately produced, and but slightly incurved; the foramen is rather large, oval, and in adult shells approximates to the umbone of the smaller valve. The external surface is smooth, marked only by a few concentric lines of growth, and the intimate shell-structure is minutely perforated by small punctures, which may be easily detected on all specimens of which the shell has not been affected by metamorphic action. In the interior of the ventral valve there exists two short diverging dental or rostral shelly plates, while in the interior of the dorsal one a short simple loop is observed, occupying about one-third of the length of the valve, as in Lign. fig. 3.



Lign. 3.—TEREBRATULA HASTATA.
Interior of dorsal valve.

Terebratula hastata was ornamented with stripes, in all probability of a red colour, similar to that still found on several of the recent forms; but it is rare to find colour-markings preserved on the surface of palæozoic shells; some examples in England and in Ireland have been found to be thus ornamented, and one was recently discovered in Scotland by Mr. J. Young.

Scottish examples of this shell do not appear to have been so numerous as, or to have attained the dimensions of some of, those that have been found in England and Ireland. The largest individual that I have hitherto seen is from the last-named country, and is in the possession of Dr. Bowerbank; it measures 26½ lines in length by 19 in breadth and 13 in width.

T. hastata occurs at about 375 fathoms below the Ell-coal at Nellfield and Braidwood, and at 391 fathoms at Braidwood Gill, in the parish of Carluke; it is found also at Capel Rig, East Kilbride, eight miles S.S.E. from Glasgow; also at Calderside and Auchentibber, High Blantyre, and Brockley, near Lesmahago, in Lanarkshire. In Renfrewshire it occurs at Arden quarry, near Thornlie Bank, four miles south from Glasgow. In Stirlingshire it may be collected from the Craigenglen beds, the main limestone, and Corrie Burn beds. In Ayrshire, at Craigie, near Kilmarnock, at Auchenskeigh, near Dalry, and West Broadstone, near Beith. In Fifeshire, at Limekilns.[*]

II.—TEREBRATULA SACCULUS. Martin, sp. Pl. xii., figs. 3, 4.

Conchyliolithus anomites sacculus, Martin. Petreficata Derbiensia, tab. xlvi., figs. 1-2, 1809; and Dav. Mon. Carb., p. 14, pl. i., figs. 23, 24, 27, 29, 30.

Shell ovate, or somewhat pentagonal in shape; notched and emarginated in front, smooth; valves nearly equally convex, with a slight depression near the front in the dorsal valve, and a rather deep mesial furrow in the ventral one. *T. sacculus* does not appear to attain the dimensions of *T. hastata*; and is, comparatively speaking, much more convex. Martin states that "the form of the shell is purse-like, its margin blunt, hollowed out opposite the beak by an obtuse indentation, which is sometimes continued along the back of the beaked valve in the shape of a slight hollow furrow or wave." That last-named character is that which generally distinguishes it best from *T. hastata* and *T. vesicularis;* but, although this peculiar sinus is well and deeply marked in many individuals, it is at times but obscurely seen in others; and this circumstance has no doubt tempted some palæontologists to unite both Sowerby's and Martin's shells under a single denomination.

---

[*] In order to avoid unnecessary repetitions, I may here mention that most of the specimens from Lanarkshire were kindly communicated by Mr. Armstrong, Mr. Bennie, Dr. Slimon, and a friend in Carluke. Those from Stirlingshire by Mr. Young. The Renfrewshire, Dumbartonshire, and Ayrshire specimens were lent by Messrs. J. Thompson and J. Armstrong, while those from the Lothians and Fifeshire were communicated to me some years ago by Dr. Fleming, H. Miller, etc.

I am acquainted with but few Scottish specimens. It was found by Dr. Fleming somewhere in West-Lothian; and Mr. Armstrong collected a few examples at West Broadstone, near Beith, in Ayrshire.

III.—TEREBRATULA VESICULARIS. De Koninck. Pl. xii., fig. 5.

Terebratula vesicularis, De Koninck, Animaux Fossils de la Belgique (Suppl.), p. 666, pl. lvi., fig. 10, 1851. Dav. Mon. Carb., p. 15; pl. i., figs. 25, 26, 28, 31, 32; pl. ii., figs. 1-8.

This small shell usually presents an ovate or pentagonal shape, is longer than wide, with its greatest breadth near the middle. In some adult examples, and in all young individuals, the valves are evenly and moderately convex, but after a certain age a sinus with two lateral ridges is developed in the dorsal valve; and at a still later period a small central elevation or rib is produced towards the front, forming a somewhat W-shaped frontal wave, of which the angles would be rounded. The ventral, or larger valve, is deeper and more inflated than the opposite one; the beak rounded and incurved; foramen small, and partly surrounded and separated from the hinge-line by a small deltidium; surface smooth. The internal dispositions are quite similar to those of *T. hastata* and *T. sacculus*. *T. vesicularis* is a small shell, and may be distinguished from the last-named species by the small mesial rib in the dorsal valve.

I am acquainted with but one or two examples which were found somewhere in West-Lothian by the late Dr. Fleming.

[NOTA.—The three species of Terebratula above described are all with which I am acquainted from the Carboniferous rocks of Scotland. At page 17 of my "Monograph," published by the Palæontographical Society, I mentioned that Dr. Fleming possessed a Terebratula from West-Lothian, which I thought might be referred to *Terebratula Gillingensis;* but, after further examination, it has appeared to me that the specimen in question may be only a young shell of *T. hastata.*]

FAMILY SPIRIFERIDÆ.*

Of the several genera and sub-genera of which this family is composed, *Athyris, Retzia, Spirifera, and Spiriferina* alone have hitherto been found represented in the Scottish carboniferous strata. All are provided with spiral appendages for the support of the oral arms.

GENUS ATHYRIS, M'Coy, 1844. (Spirigera, d'Orbigny.)

The species belonging to this genus bear so much external resemblance to many species of Terebratula, that they were for long referred to that genus; but they are clearly distinguished by their non-perforated, or fibrous shell-structure, as well as by their internal arrangements.

The Carboniferous rocks of Scotland have hitherto furnished us with but three species, viz., *A. ambigua*, *A. plano-sulcata*, and *A. Royssii.*

IV.—ATHYRIS AMBIGUA. Sowerby sp. Pl. xii., figs. 6-9.

Spirifera ambigua, Sow. Min. Con., vol. iv., p. 105, tab. ccclxxvi., 1822; *Athyris ambigua*, Dav. Mon. Carb., p. 77, pl. xv., figs. 16-22, and pl. xvii., figs. 11-14.

In external shape it is more or less obscurely pentagonal, and generally rather wider than long. The valves are moderately convex; the dorsal one being more often divided into three or four lobes from the central fold, presenting a narrow mesial groove, while a longitudinal and somewhat angular sinus extends from the extremity of the beak to the frontal margin in the dorsal one. The beak is not much produced or incurved, and is truncated by a small circular foramen, which lies contiguous to the umbone of the smaller valve. Externally the shell is smooth, being marked only by a few lines of growth. In the interior the spiral appendages are directed outwards, as may be seen in the figure, lign. 3. page 99, of this volume.

---

* At page 457 and following of the first volume of "THE GEOLOGIST" the reader will find copious details and illustrations in connection with the genera and sub-genera of which this family is composed.

In the larger, or ventral valve, the hinge-teeth are supported by vertical shelly plates, and the free space at the bottom of the valve between and beyond these is filled up with muscular impressions. The muscle, whose function was the closing of the shell, has formed a small elongated, mesial, heart-shaped scar; and under, as well as along the outer side, are seen the impressions of the cardinal or divaricator muscles—that is to say, of those which had the office of opening the shell, the impressions of the pedicle, or ventral adjustor muscle may also be detected, on either side, close to the adductor. In the interior of the smaller or dorsal valve the hinge-plate presents four depressions, which afforded attachment to the dorsal pedicle, or dorsal adjustor muscles; the hinge-plate is likewise perforated close to its summit (under the umbone) by a minute circular aperture. On the bottom of the valve, divided by a small longitudinal ridge, may be seen the quadruple impressions left by the adductor, or posterior and anterior occlusor muscles. These details are beautifully displayed in some valves from Capel Rig, East Kilbride, which were kindly communicated by Mr. Armstrong, and which will be found represented in pl. xii., figs. 8-9.

Some specimens of this shell from Lanarkshire (wherein the mesial groove of the dorsal valve was not so apparent or distinctly marked as in the ordinary and typical shapes of the species) have been referred by Professor M'Coy to Phillips' *A. globularis*, but of which species I have not hitherto seen any well-authenticated Scottish examples. Some specimens have likewise presented externally a deceptive appearance of striation, but which is not the character of the well-preserved shell.

Athyris ambigua is one of the commonest of the Scottish carboniferous species. In the parish of Carluke it is plentiful in the upper limestone series, but also hundreds of fathoms lower in the series—that is, in the shelly limestone band, a few feet above the "Productus giganteus bed."* Thus at Gare it may be collected at two hundred and thirty-nine fathoms, at Braidwood Gill at three hundred and ninety-three fathoms, and at Langshaw at three hundred and forty-three fathoms below the horizon of the "Ell coal." In Lanarkshire (besides the localities just mentioned) it is found at Lawrieston and Capel Rig, East Kilbride; at Calderside and Auchentibber, High Blantyre; at Brockley, near Lesmahago; and Robroyston to the north of Glasgow. In Stirlingshire it is found at Campsie, in the Craigenglen, Balglass, Mill Burn, Balgrochen, Main limestone, and Corrie Burn beds. In Renfrewshire it is plentiful at Floor's quarry Johnstone Bridge, Barrhead, Arden quarry, and Orchard, near Thornliebank. In Ayrshire it occurs at Roughwood and West Broadstone, Beith; at Auchenskeigh, Dalry; Goldcraig, Kilwinning, Hallerhirst, Stevenston; and Craigie, near Kilmarnock, &c., &c. It is also found in the Island of Arran. In Haddingtonshire it is to be collected at Cat Craig, near Dunbar; and in many other places which need not be enumerated.

---

* In Ireland it is most abundant, under the shape of casts in the red sandstone of Kildress which is still lower down in the series than is the great "Productus bed" above referred to.

V.—ATHYRIS PLANO-SULCATA. Phillips sp. Pl. xii, figs. 10, 11.

Spirifera plano-sulcata, Phillips, Geology of Yorkshire, vol. ii., p. 220, pl. x., fig. 15, 1836; and Dav. Mon. Carb., p. 80, pl. xvi., figs. 2-13,15.

The shape of this shell is more often orbicular, the valves being equally deep and evenly convex, without sinus or fold, or with a slight mesial depression towards the front in one or both valves. The beak is small and incurved, with a minute foramen placed close to the umbone of the opposite valve. When perfect, the surfaces of both valves are ornamented at intervals of less than a line, with numerous concentric semi-circular lamelliform expansions, each plate being flat and longitudinally striated. It is, however, rare to obtain specimens in which the plates are in place, as they generally remain in the matrix from whence the shell is detached. The interior arrangements are similar to those of *A. ambigua.*

A. plano-sulcata does not appear to be a very common shell in Scotland; it occurs at three hundred and forty-three fathoms below the "Ell coal," and near Lesmahago, in Lanarkshire. In Stirlingshire it occurs at Craigenglen. In Renfrewshire, at Arden quarry, Thornliebank, Barrhead, etc.; in Ayrshire, at Roughwood and West Broadstone, near Beith. It has also been found in West Lothian.

VI.—ATHYRIS ROYSSII. L'Eveillé. Pl. xii, fig. 12.

Spirifer de Royssii, L'Eveillé, Mémoirs de la Société Geologique de France, vol. ii., p. 39, pl. ii., figs. 18-20, 1835; and *Athyris Royssii*, Dav. Mon. Carb., p. 84, pl. xviii., figs. 1-11.

This species is generally transversely oval and sub-globose, with equally deep and uniformly convex valves up to a certain age; after which a mesial fold of greater or lesser elevation is gradually formed in the dorsal valve, and to which corresponds a sinus in the opposite one. The frontal margin is, therefore, either nearly straight, or presenting a greater or lesser curve. The beak is incurved and truncated by a small circular foramen, which is contiguous to the umbone of the dorsal valve. Externally the entire surface is regularly covered with numerous concentric scaly ridges, from each of which radiate closely set fringes of elongated somewhat flattened spines; and, indeed, so closely packed are the spiny ridges, that in the perfect shell no portion of the valve could be perceived. Specimens are not, however, to be obtained with their spiny investment from the hard limestone matrix, but from the decomposing shales examples may sometimes be picked up in which portions of the spines are still preserved. The interior arrangements are similar to those of the two species already described.

Athyris Royssii occurs in the shales of Coalburn and Brockley, near Lesmahago, and at West Broadstone, near Beith.

SUB-GENUS RETZIA. King. 1850.

The species which compose this sub-genus are Terebratula-shaped, with a perforated, or punctured shell-structure, and by this character they appear to be chiefly distinguished from *Athyris.* Interiorly they possess spiral processes for the support of the oral arms, with their extremities directed outwards; but I have never yet succeeded in procuring a specimen wherein the details could be satisfactorily developed. I am acquainted with but a single species from the Scottish carboniferous strata.

VII.—Retzia radialis. Phillips, sp. Pl. xii., fig. 13.

Terebratula radialis, Phillips, Geology of Yorkshire, vol. ii., p. 223, pl. xii., figs. 40, 41; *Retzia radialis*, Dav. Mon. Carb., p. 87, pl. xvii., figs. 19, 21.

A single crushed example of this small species from Scotland has come under my examination; it was derived from the Carboniferous shales of the neighbourhood of Lesmahago by Dr. Slimon. When perfect it possessed a longitudinal oval shape, with valves almost equally and moderately convex. The beak is produced and truncated by a small circular foramen, which is slightly separated from the hinge line by a small hinge area. Each valve is ornamented with about twenty small rounded, radiating ribs, of which the central one in the dorsal valve is at times the largest, and to which, in the ventral one, corresponds a deepened sulcus.

(To be continued.)

FOREIGN CORRESPONDENCE.

By Count Marschall, of Vienna.

On Fossil Vertebrata. By Professor E. Suess. *Read before the Imperial Geological Institute of Vienna, Feb.* 8, 1859.

M. Gastaldi has recently published an essay on the fossil Vertebrata of Piedmont, especially on the Mammals found in the coal of Cadibona, which he and Prof. Michelotti consider to be of Lower Miocene age; while Prof. Sismonda and Dr. Rolle think the shells occurring in it to be rather of Eocene character. The upper portions with *Tetralophodon Arvernensis*, *Hippopotamus major*, &c., are called Pleistocene by M. Gastaldi, while Dr. Falconer has evidently proved them to be genuine Pliocenes like the deposits of the Arne-valley, the Auvergne (partly), and the mammaliferous Crag of England. As it is still to be proved (according to Prof. Heer's deductions) that physical changes must necessarily have affected in the same degree the inhabitants of the dry land as they did those of the sea, much confusion would be avoided by using local denominations (Arno-, Eppelsheim-, Cadibona-fauna, &c.,) instead of hypothetical geological terms (as miocene, pliocene, &c.). M. Gastaldi's excellent descriptions and figures have materially contributed to give clearer notions of *Anthracotherium magnum*, *Anthr. minimum*, *Amphitragulus communis*, *Rhinoceros minutus*, *Rh. incisivus*; the last species is still doubtful.

The Swiss lower Molasse, the coal of Kovencedo, near Vicenza, and probably some other more eastern deposits may be coeval with those of Cadibona. The remains of *Rhinoceros* from the brown-coal of Hart, near Gloggnitz, belong to a smaller species not occurring elsewhere within the Vienna-basin, and possibly identical with that of Nuceto, referred to by M. Gastaldi to *Rhin. minutus*, Cuv. Chev. Fr. de Hauer has remarked, respecting the stratigraphical circumstances, that the coal of Breemberg (W. Hungary) may be of more ancient date than the lowermost marine deposits of the Vienna basin.

Prof. E. Suess on some Fossil Bovidæ. Proceed. Imp. Geol. Institute of Vienna, March 29, 1859.

The Imperial Geological Institute of Vienna has purchased a collection of mammalian remains obtained from the Galician Loess, an ancient loam deposited in the valleys of the rivers Wistock and Dunajec. This region, long ago renowned for its abundance of fossil remains, is no less conspicuous for the uniformity of its ancient fauna, represented only by three herbivorous species—*Bospriscus*, *Bos primigenius*, and *Elephas primigenius* (the last by far the most prevalent). The skulls of the two species of *Bos* offer very striking differences in their structure and proportions. In *Bos priscus* the frontal bone is vaulted, and has no superior edge prominent over the surface of the occipital bone; the basis of the horns is somewhat beneath the upper frontal edge; the horns are proportionally short, strong, directed horizontally outwards, with ends slightly curved upwards; the orbits are nearly beneath the bases of the horn-roots. *Bos primigenius* has a narrow concave forehead, forming upwards a strong edge prominent over the surface of the occipital; the horns are inserted exactly on the upper margin of the frontal, and are longer and more curved than those of *B. priscus;* they are directed horizontally outwards, then inclined inwards with ends slightly curved downwards. The orbits are far beneath the roots of the horns, with a deep depression in the middle of the forehead between them.

On Listriodon. Prof. E. Suess. Proceed. Imp. Geol. Institute of Vienna, March 29, 1859.

A molar of *Listriodon splendens*, H. v. Meyer, (*Tapirotherium* of some French palæontologists) has been recently found in the Leitha limestone of Fünfkirchen, Central Hungary. The same species is known to occur in the Leitha Mountains, between Austria and Hungary; and in France, Départment du Gers and Départment de la Drôme; a proof that the fauna of the epoch, as the subsequent one of Eppelsheim, far from being a merely local one, extended over a large portion of Europe.

Prof. Unger on the Plants of Egypt. Proceed. Imp. Academy, Vienna, July 14, 1859.

Among the plants, the remains of which are to be found in sepulchres, or figured on the monuments, etc. of Egypt, some fifty

species admit botanical determination. Nearly the whole of these species were objects of culture, and consequently introduced from other countries simultaneously with, or soon after, the immigration of the tribes who peopled ancient Egypt. Many of them, as the date-palm, the flax, the cerealia, etc., may be proved to have been cultivated as early as under the reign of Menes (B.C., 3623). Prof. Unger has found no traces of any change from one species into another having taken place during a period of nearly fifty centuries, from Menes to our times.

Ossiferous Cavern. Proceed. Imp. Academy, Vienna, July 14, 1859. Prof. O. Schmidt, of Gratz, has found in the Grebeuzer Alp, Upper Styria, a fissure, or cavern, containing remarkably well preserved remains of the Elk, together with those of another extinct species of the genus Cervus.

GEOLOGICAL TOPICS.

THE FIRST TRACES OF MAN ON THE EARTH.

(Continued from page 434.)

The second volume of M. de Perthes' book, that which we have to deal with especially in this notice, is illustrated by twenty-six plates containing nearly five hundred figures. In the interim, too, between the publication of the first and second volumes, that author added greatly to his collection of primitive (antediluvian) and Celtic instruments (those of historic periods). This collection is now unrivalled, and has been accumulated by travels and purchases from all parts of the world. To make sure of the origin of these objects, M. Boucher de Perthes has himself been to search for them, not only in the North, in Denmark, Sweden, Norway, Lithuania, Poland, and Russia, but also in the South, where these stone-implements are much rarer, in Spain, Italy, Sicily, Greece, Turkey, along the shores of the Black Sea, and lastly, he has carried his researches even into Asia and the French African possessions. His object in these travels was not only to collect specimens, but also to consult foreign *savans;* and he acknowledges in glowing terms the courtesy he everywhere met with, and the flattering and ready aid given to his researches. His book, so controverted in France, he found had met with better reception abroad, and morever that it had also been better comprehended as detailing the proofs that "a race before unknown, a human family of which the origin was lost in the night of Time—a race contemporaneous with the great pachyderms of which we find the remains, had lived upon the soil we tread, and, many ages old, had been witness to terrible revolutions, and at length to that last catastrophe which had changed the surface of the globe, and modified, with its climates, the form of nearly every living species." The former long existence in Europe of this people, which M. Boucher de Perthes considers to have ended with the Deluge, is supported by demonstrative proofs.

It is thus that author opens out a new branch of science—"Archeo-geology" for the investigations of the historian, the antiquary, and the geologist.

"Since," continues the writer of the preface before quoted, "the way is open, let us follow the author; the first who do so will find ample reward. Soon it will not be a single gallery that will suffice to contain the relics of the past: it is an entire museum under the porticos of which should figure also the tools, the dolmans, the raised stones, antique evidences, if not of the aptitude, at least of the power, of man; for the erection of these monoliths without the aid of machines is still a problem. But, hasten we on: that which age and barbarism have spared disappears before civilization. Broken by the hammer or cut by the saw, these oldest of our monuments have already, at more than one point, served to pave the road, or to form the abutment of a bridge. If governmental protection does not take them under its safe-guard they will all perish. . . . No! these stones great and small, arms, utensils, idols, symbols, or characters, are not to be disdained: a whole suite of revelations is there. Not solely those which prove the existence of a people, but those which shew its whole life, for they indicate not simply their domestic habits, their means of living or of satisfying the necessities of the moment, . . . they prove that there was in them a sentiment of futurity, a belief, a faith, a religious want, an adoration, lastly that they had a perception of the divinity. Yes! upon the first men who united their efforts to dress this stone, who worked off the angles to make the form regular . . . a ray of light from on high had descended; they had drawn near to heaven; it was a first homage which they rendered to God. Let us render it like them, and break not His altar."

There is certainly something very beautiful in these speculations; and nothing will link our minds so closely to the study of the changing phases of the earth's antique history as thus associating the primitive tribes of our race with the events of a vastly remote geologic age. M. Boucher de Perthes' book is however highly speculative throughout; and we would have our readers bear in mind that we are at present only attempting to detail, as concisely and as accurately as we can, the ideas he has put before the world. Undoubtedly these speculations were in the first instance, and still are, a great barrier to the acceptance of his book; for in many instance we ourselves cannot but regard them as visionary. In saying this, however, we wish not to detract from the real merits of his labours, for we willingly admit that in some of the wildest of his notions, there lies latent a germ of truth, valuable alike to the antiquary and to the geologist.

It is somehow a character of the French light style of writing that they tell you a great deal about themselves, at the same time that they are telling their story and describing what they have seen. The reward of the geologist, as M. Boucher de Perthes in his first chapter aptly remarks, is immediate and positive. He sees at once in the simple section the superposition of the beds, their identical or their different character. The same with the archæologist. It is not difficult in the soil which he opens to perceive the fibula, the statue, or the coin; the broken fragments of a vase, a brick, or tile inspire him with confidence, and the hope of finding better, and hope doubles the zeal of even the mere workman who always believes in finding a hoard of gold. "It is not thus in the diluvium. There everything is sand, flints, blocks of stone, and far and far between, some gigantic tooth, some enormous fragment of the head or femur of an elephant, or a rhinoceros, which, after having evoked the curiosity of the worker leaves him but regret: scarcely is the debris of the giant of former ages divested of its matrix and exposed to the air than one sees it crumble away and resolve itself into dust. What remains then for the inquirer! A souvenir, an indication: still it is not this for which he searches.

Alone in front of these masses of sand piled in horizontal beds, curved into a … he hesitates at the task he has imposed

FOR CHRISTMAS PRESENTS.
IN FOOLSCAP QUARTO, HANDSOMELY BOUND.
WILLY'S BOOK OF BIRDS
BY MRS MACKIE,
ILLUSTRATED WITH SIXTEEN
BEAUTIFUL PLATES FROM ORIGINAL SPECIMENS
PRICE PLAIN 6/- COLD BY HAND 7/6
LONDON, GEOLOGIST OFFICE, 154, STRAND.
1859.

nifers, covered with … envelope. In the new valleys, then, in those reservoirs … torrent, are piled pell-mell bodies and relics, traces of that which had been brought to an end.

"Is it not what we see after inundations and rain-storms? Yes. It was in these deposits, in these deluvial débris, that I did at last find a trace of man, and my joy was great when I had found it."

Many other antiquaries follow the old and exploded notion of these so-called diluvial gravels having been solely formed by the action of water. This is an error, for water has been only the motive power in their distribution. Beyond this, all it has effected has been by its continued frictional action in the partial rounding by abrasion of the sharp angular edges of those more or less triangular fragments into which flints naturally break by the action of frost or by percussion. Whole beds of shattered flints are of frequent occurrence in chalk, and the mere waste and destruction of the strata would liberate heaps of fragments with angular edges as sharp as those of a flint freshly broken by the hammer. The knocking action of one pebble dashed against another could not produce the triangular pieces we have alluded to, but would cover the surface with innumerable pits, due to the natural conchoidal fracture of the chips broken out.

M. de Perthes next details the researches made by himself, Dr. Rigolet, and others in the neighbourhoods of Abbeville and Amiens, some accounts of which were, from time to time, laid before the "Société d'Emulation" of Abbeville, and "Société des Antiquaires de Picardie," and published in their respective transactions.

(To be continued.)

BRITISH ASSOCIATION MEETING.

(Continued from page 444).

Queries on Slickensides submitted to the President of the Geological Section, Aberdeen Meeting, September, 1859, by Mr. J. Price, of Birkenhead, with Replies to the Queries by Professor D. T. Ansted.

I offered the following remarks to the Section, under a conviction that individual and local observation of small facts could never, as such, be out of place at the meetings of an association so eminently Baconian as that then assembled at Aberdeen; and that this must ever be the province of the majority of naturalists—to provide instances for the few master minds to generalize. I mean to include under the name "Slickensides" every mineral surface which, apart from crystallization, exhibits an extraordinary degree of polish. And as I believe this phenomenon has never yet received anything approaching to a satisfactory explanation, I wish to call the attention of practical geologists to the subject, and induce them to look out for it in sections (whether natural or artificial) of every rock-formation. I am acquainted with the fact *in situ* only in the neighbourhood of Birkenhead (New Red), particularly the celebrated Labyrinthodon quarries at Storeton, where it is very well illustrated, and in the "mountain-limestone" at Llysfaen and Bryn Euryn, near Abergele, North Wales. But I believe I have met with hand specimens of it (generally ballast) in granite, serpentine, coal, coal-shale, and trap, near Shrewsbury. I presume "specular" galena, antimony, &c., to be the same fact. I hardly ever saw it *in situ* without finding two contiguous instances—*i. e.*, two pairs of polished surfaces sometimes within half an inch, sometimes two feet of each other, the intervening space being occupied by rock more or less altered in character, and generally more compact. The planes never agreeing with the stratification, and often nearly perpendicular to it. I never saw any termination of the polished planes, so that I should suppose they intersect whole mountains. In granite and trap the surfaces I have seen were far from plane, and exhibited a different substance rather like steatite or soapstone (so in serpentine). In sandstone the polish is such as could not be produced by artificial means (without vitrifying); but, however sleek the surface, it always exhibits striæ, sometimes parallel, but often inclined at various angles. The following questions seem worth following up, to obtain more light on the subject:—

1. Are all rocks found to exhibit these surfaces?

2. If so, are the circumstances alike in the main?

3. If not, what sort of rocks seem excepted?

4. Are conglomerates exempt? Is chalk? Is rock-salt?

5. Is it a question of age? Is it as common in Old Red as in New?

6. If in roofing slate, what is its relation to cleavage?

7. If in trap-dikes, does it crop the dike?

8. If in soft silurian shale ("mudstone") does it harden that? N.B. It does not seem to alter coal at all, and I have seen something very like it in clay, not so hard as French chalk.

9. Is it found to pass into contiguous rocks, that overlie—*e. g.*, from Mountain-limestone into Old Red sandstone.

10. Does it ever pass into rocks lying conformably?

11. Does it affect the accidental minerals of the rock through which it passes—*e. g.*, Barytes in Mountain-limestone?

12. Does crystallization interrupt it, or *vice versâ?*

13. Are the striæ universal?

14. Does it never correspond with stratification?

15. Are the surfaces coated with a different substance, or is it merely the rock itself altered?

16. Has it been seen on the opposite sides of valleys, or of mountains?

17. Have the apparently parallel pairs been found to meet, and so come to an end? I have seen something like this.

Mr. Cunningham asserts that here they form a barrier to springs of water. Is this general?

Allow me to commend to the notice of tourist-geologists Llysfaen, near Abergele, as exhibiting within a very small compass five very remarkable and perfectly distinct drifts; also a good mountain-limestone fossil station, with a good flora (silurian fossils near) between Rhyl and Llandudno.

Additional Queries.—18. Does the "slick" or polished surface indicate a fault?

19. Is the "slick" ever intersected by mineral veins?

20. Are the perfectly level "specular" surfaces and those which, though glossy, are uneven, to be referred to the same agency?

21. Do they ever coincide with the stratification, partings, cleavage, "lamination," or "foliation" (E. Forbes), and are they to be considered as absolutely *sui generis*, or to be classed with some of these?

22. I have heard them called "trap dykes." Is this name justified in any localities?

23. In what relation do they stand to fossils?

Here (Birkenhead, &c.), where they abound, nothing ever intervenes between the two pairs of "slicks" but sandstone (sometimes altered); elsewhere the coal, though highly polished, is simply coal. Sir C. Lyell mentions polished surfaces produced by molten lava passing through fissures in old lava. And this reminded me of a "slick," as there would, of course, be four surfaces (two *vis-a-vis*) in those dykes of Somma.

I have more hopes of this curious subject being pressed, since Mr. Cunningham, of Liverpool, by giving it a practical turn in connection with a "water question," has enlisted the *cui bono* party in our inquiry. If they form a barrier to subterraneous "water-works," they want looking after indeed.

Replies to Mr. Price's Queries.—1. Slickensides occur, I believe, in all hard metamorphosed partly crystalline rocks, and especially in limestones, sandstones, and perhaps some slates. They occur also in some clays and in coal.

2. The general conditions being the same, the phenomena are very similar, but they vary greatly with the nature of the rock.

3. Soft sands, uncrystallized limestones, and some clays are excepted.

4. I never saw a case in conglomerates, but should not be surprized at finding one. The same with rock-salt. Chalk is exempt.

5. It is not a question of age. I am not aware of any difference between Old and New Red sandstone that could affect the question.

6. I never saw a true slick in roofing-slate, but I think I have in indurated slate. It can have no relation to cleavage.

7. There is no reason why it should not.

8. Very similar, if not identical, phenomena are common in some clays, chiefly very smooth and fine-grained varieties. It does not harden such clays, nor does it alter them.

9. In passing from one rock to another of very different mineral character, the appearance of the slick is so different that it could hardly be identified.

10. Yes.

11. It makes a clear cut through the limestone and its contents.

12. No, to the best of my knowledge.

13. They vary in each case. Some striation or approximate appearance I have always seen.

14. Not that I am aware of.

15. The rock itself altered by compression, and perhaps by heat produced by friction.

16. Not that I am aware of.

17. I believe the opposite faces where the slick is compound are not strictly parallel, but wedge-shaped.

18. Not necessarily a fault affecting underlying beds, but a slide of the bed in which it occurs, though often to a very small extent, and locally.

19. I think I have seen instances of it.

20. Yes.

21. I believe them to be *sui generis*.

22. No.

23. They may occasionally intersect fossils, but the surface change has, as far as I have seen, always obliterated all organic character.—D. J. Ansted.

Abstract of a Paper "ON SOME FISHES AND TRACKS FROM THE PASSAGE-ROCKS, AND FROM THE LOWER RED SANDSTONE OF HEREFORDSHIRE." BY THE REV. W. S. SYMONDS, F.G.S.

Mr. Symonds, in this paper, called upon Sir Roderick Murchison to make greater allowances than he had hitherto seemed disposed to do for the appearance of fish in the Lower Ludlow rocks of Leintwardine, Herefordshire. This fish, the *Pteraspis Ludensis* (Salter), was not found as Sir R Murchison seemed disposed to regard its discovery, in strata a few feet below the original upper Ludlow "bone-bed," but in the Lower Ludlow deposits, with the whole thickness of the Upper Ludlow shales and Aymestry rock intervening. There was no doubt of the fact that fish-life must now be immensely ante-dated, even since the publication of Sir R. Murchison's last edition of his work upon Siluria.

Mr. Symonds called the attention of the audience to a collection of fossils showing the gradation of the Pteraspis from the Lower Ludlow rocks, through those passage- or transition-rocks which lie between the upper Silurians and the Old Red sandstone, into the central Old Red rocks of Herefordshire. The species were different, but the genus was the same. Stereoscopic plates were exhibited of a large slab of Old Red sandstone which was rippled by the waves of the ancient Old Red sea, and scored deeply by some Old Red fish or crustacean which had wended its way over a shallow beach or sandy shore. The slab was obtained by the late Rev. T. T. Lewis of Aymestry, the friend and coadjutor of Sir R. I. Murchison, and who at his death left it to Mr. Symonds.

ON THE ORIGIN OF THE STRUCTURE CALLED CONE-IN-CONE, by H. C. SORBY, F.R.S., &c.

Cone in Cone is met with in so many stratified rocks, that most geologists must be familiar with its general characters. No one, however, appears to have thoroughly investigated it; or to have given any very satisfactory explanation of its origin. The cones often occur in bands parallel to the stratification of the rock, their apices starting from a well defined plane; and, after extending upwards or downwards for a greater or less distance, with their axes perpendicular to the plane of stratification, they end in bases parallel to the stratification, but not all at the same exact level. They are not perfect cones, but are of such forms as would result from the varied interference of surrounding cones, and from the development of others within their own substance. On examining thin, transparent sections with a low magnifying power, under polarized light, the author had been able to ascertain that this peculiar structure is intimately connected with some kinds of oolitic grains. In the formation of oolitic grains small prismatic crystals were deposited round a centre-nucleus, radiating to all sides in nearly the same amount, so as to give rise to irregular ovoid bodies; whereas, in the formation of cone in cone, very similar crystals were deposited almost entirely on one side, along the line of the axes of the cones, in such a fan-shaped manner as to give rise to their conical shape. In the thin sections of some specimens prepared for examination, every connecting link between imperfect oolitic grains and genuine cones can be seen to great advantage with polarized light. The growth of the cones did not, however, proceed without interruption, for other smaller fan-shaped groups were developed within the larger; and thus by the mutual interference of contiguous groups and of others contained within themselves, there was formed a mass of irregular cones inclosing other cones. We must therefore conclude that this structure is one of the peculiar forms produced by concretionary crystalization after the deposition of the rock.

PROCEEDINGS OF GEOLOGICAL SOCIETIES.

Geological Society of London, *November* 2, 1859.—Prof. J. Phillips President, in the Chair.

The following communications were read:—

1. "On the Passage-beds from the Upper Silurian Rocks into the Lower Old Red Sandstone, at Ledbury, Herefordshire." By the Rev. W. S. Symonds, F.G.S.

In the cutting at the Ledbury Tunnel, on the Worcester and Hereford Railway, a series of beds have been exposed, which range from the Upper Silurian or Downton beds to the Old Red sandstone, including bluish-grey rock with fossil fish, crustaceans, and shells, like those found in the railway-cutting and elsewhere near Ludlow. The following is the ascending order of the beds observed:—1. Aymestry rock, with *Pentamerus Knightii*, &c. (ten feet). 2. Upper Ludlow rock, with *Chonetes lata*, &c. (one hundred and forty feet. The Ludlow Bone-bed seems to be wanting here). 3. Downton bed, thin (nine feet), with *Lingula*. 4 to 8. Red and mottled marls and thin sandstone (two hundred and ten feet), with *Lingula* and *Pteraspis* (?). 9. Grey shale and thin grit (eight feet), with *Cephalaspis* and *Pterygotus*. 10 and 11. Purple shales and thin sandstones (thirty-four feet). 12. Grey marl, passing into red and grey marl and bluish-grey rock (twenty feet), with *Auchenaspis*, *Plectrodus*, *Cephalaspis* (?), *Onchus*, *Pterygotus Ludensis*, *Lingula*, and a Lituite (?). These pass upwards conformably into a series of red marls, with yellowish-grey and pink sandstone, containing *Pteraspis* and *Cephalaspis*, and undoubtedly forming the base of the Cornstone-series of the Old Red Sandstone. The author remarks that there are other cornstones, namely those of Wall-hills near Ledbury, of Foxley, Writfield, &c., which are at least three thousand feet above the Downton sandstone. He also remarks that, as the word "Tilestones" is inapplicable to the Ledbury rocks, he quite agrees with Sir R. Murchison in replacing it by the term "Passage-beds."

2. "On the so-called Mud-volcanos of Turbaco, near Carthagena." By F. Bernal, Esq.; in a letter to Sir R. I. Murchison, F.G.S.

Turbaco is a village, about fifteen miles from Carthagena, at an elevation of about nine hundred and eighty feet above the sea. At a distance of about three miles from the village, and at a higher elevation, in the midst ef a forest, are some twenty or thirty conical hillocks, about eight or ten feet high, each with its little crater or orifice, about two feet in diameter. These are filled with a muddy water; and every two or three minutes a slight noise is heard, a bubbling up of air or gas takes place, the muddy fluid runs over, and forms into cakes of blue clay. The water is quite cool, nor is there any present or anterior marks or vestiges of the action of fire or heat.

3. "On the Coal-formation at Auckland, New Zealand." By Henry Weeks, Esq., communicated by the President.

The district is formed of stratified sandy clays, of Tertiary age; they vary in colour from white to light-red. The white clays contain beds of lignite, varying from a few inches to several feet in thickness. Sections of these beds are exposed along the banks of most of the tidal inlets with which the district abounds. In some places, near the hills, the lignite is seen to rest on trap-rock; elsewhere a shelly gravel underlies it.

At Campbell's farm a whitish sandstone lies on the lignite, and at the junction is hardened and contains ironstone-nodules; these, when broken, yield remains of exogenous plants. A fossil resin is found abundantly in the lignite. On Farmer's land the lignite is sixteen feet thick, ineluding a little shale; at Campbell's it is seven thick, but thins away. There is some iron-pyrites in the lignite, but not sufficient to deteriorate its value as a coal. Similar coal has been found at Muddy Creek to the N.W.; at Mokau, about one hundred miles to the south; and near new Plymouth.

The Auckland tertiary beds are everywhere broken through by extinct volcanos, varying from two hundred to eight hundred feet in height. The craters are generally scoriaceous, in a perfect condition, with a depression of the rim usually to the north or east. There are also around the district other volcanic hills, rounded, scoriaceous, more fertile than the crateriform hills, and apparently of an older date.

4. "On the Geology of the South-east part of Vancouver's Island." By Hilary Bauerman, Esq., communicated by Sir R. I. Murchison, F.G.S.

The author described, first, the metamorphic rocks which are everywhere seen in the neighbourhood of Esquimalt and Victoria; principally dark-green sandstones and shales, passing insensibly into serpentine, chlorite-schist, mica-slate, and gneiss. At some places unfossiliferous crystalline limestones are associated with them. Dykes of greenstone, syenite, porphyries, and trap-rocks frequently penetrate the metamorphic rocks. To the westward of Esquimalt black cherty limestones and red porphyry occur.

To the north, at Nanaimo, rocks with cretaceous fossils appear, also at Comoux Island, twenty one miles north-west of Nanaimo. The fossils occur in nodules, and consist of fish-scales, *Nautilus*, *Ammonites Baculites*, *Inoceramus*, *Astarte* (?), *Terebratula*.

Lignitiferous deposits (sandstones, grits, conglomerates, and micaceous flagstones) succeed the cretaceous rocks, and are extensively developed over a great extent of country, forming the mass of the islands in the Gulf of Georgia, as far south as Saturna Island. Northward they occur at Fort Rupert. Two seams of coal, averaging six to eight feet each in thickness, occur in these beds, and are extensively worked for the supply of the steamers navigating between Victoria and the Frazer River. The coal is a soft black lignite, interspersed with small lenticular bands of bright crystalline coal. Retinite is common in the more earthy portions. Shales with plant-remains are interstratified with the lignite. At Bellingham Bay, on the mainland, similar coal-bearing sandstones have been observed by the American geologists.

A pleistocene boulder-clay is widely distributed over the southern part of Vancouver's Island and the opposite coasts of the mainland. In the neighbourhood of Esquimalt and Victoria the rocks are deeply scratched and grooved along the shore; and so also is the rock-surface beneath the drift, which at Esquimalt Harbour is about twenty feet thick, whilst it is much more at the Barracks, and more than one hundred feet thick between Albert Head and Esquimalt.

November 16.—"Supplemental Observations on the Order of the Ancient Stratified Rocks of the North of Scotland and their associated Eruptive Rocks." By Sir R. I. Murchison, V.P.R.S., F.G.S., &c.

These observations were founded on a joint-examination of the north-west highlands by the author and Prof. Ramsay, in the autumn of this year, Sir Roderick having been anxious to verify and enlarge his previous researches in Sutherland and Ross, the results of which were published in the Society's Journal of August last. Professor Ramsay's examination of the country resulted in the confirmation of the author's published views; and in a very careful working out of three important sections, which afforded distinct evidence of the continuous succession and conformability of the micaceous flagstones overlying the quartz-rocks and limestones of Durness and Assynt. The author mentioned also that Professor Harkness, having subsequently traversed the ground, had supplied him with sections and notes confirming the accuracy of his views, and especially illustrative of that phenomenon to which Sir Roderick had attributed the greatest importance, namely, the broad distinction between the fundamental gneiss and the micaceous schists and flagstones superposed on the Silurian quartz-rocks and limestones.

Referring to the gneiss of Cape Wrath as the fundamental rock of the district, and as the equivalent of the "Laurentian rocks" of Canada, Sir Roderick pointed out its massiveness, its granite-veins, its high degree of metamorphism, and the westerly dip of its laminæ, as characters distinguishing it from the micaceous flagstone and chloritic schists which have been termed the "younger gneiss," which has a general easterly dip, and which, when near intrusive rocks, take on a gneissose structure, especially to the east. A few more details were given of the red sandstones and conglomerates of Cambrian age lying unconformably on gneiss. The Silurian quartz-rocks and limestone were then described as seen in their successive and conformable strata in three clear and important sections, showing how completely the chief limestones lie between a lower and an upper quartz-rock; and how all this series is followed by another limestone, which in its turn is conformably overlaid by micaceous flagstones. The first of these sections is to be traversed along a line from the post-office of Assynt, on the west, across the ridges of limestone of Inchnadamff to the quartzose hills of Cnocandrien, Ben Uran, and Ben More, to Kinloch and Loch Ailsh. Some greenstones are interbedded at Inchnadamff and at Loch Ailsh, and some porphyry intrudes at Cnocandrien, but the conformable sequence of the strata is not thereby at all interfered with.

The next section is on the south bank of Loch More. Here the lower quartz-rock lies unconformably on the bottom gneiss, the Cambrian rocks being absent, and a gradual passage from the upper quartz-rock into the micaceous flags of Ben Neath and Kinloch was clearly seen. A third, and, if anything, a still better section was followed from Benspionnach, on the west, across Loch Eriboll to Meolbadvartie and Ben Hope. Above Eriboll a specimen of *Orthoceras Brongniartii* has been found in the quartz-rock overlying the lower limestone. The upper limestone is here overlaid by a clear succession of quartzose beds and micaceous flagstones, which pass upwards into mica-schists of Meolbadvartie, in which is interbedded a thin band of felstone, without any disturbance. This condition of the strata extends along the strike for twenty or thirty miles at least. At Whiten Head, the northern prolongation of the quartz-rock of Eriboll, the limestone has died out, and the two quartzose bands have united into one great series. The author observed no reversal in the dip of the overlying micaceous beds at any point along the northern coast; and he was strengthened in his conviction that these flaggy strata, altered here and there by plutonic influences, are really an overlying series, younger in age than the lower Silurian quartz-rocks and limestones of Durness and Assynt. Sir Roderick further repeated his belief that probably the crystalline rocks of the Highlands will be mainly found to fall into the same category, and will in time be paralleled with Silurian rocks of the south of Scotland. Lastly, he observed that, with local exceptions, he believed that these flagstones and mica-schists were unaffected by mechanical cleavage.

Geologists' Association.—The meetings of this Society were resumed on [illegible] 3rd, when the first part of a Memoir on the Echinidæ of the Chalk, [illegible], Esq., was read. At the second meeting, on the 7th ult., the [illegible]is paper was concluded.

The author commenced by indicating the position of the Echinidæ as a large and important section of the Radiata, and pointed out the several steps in the series which connected the completely circular types with those having a marked tendency towards bilaterality.

The principal characteristics of the order were then enumerated, commencing with a description of the calcareous shell, or test, constituting an internal and integral portion of the animal being secreted by and enclosed within organized membranes, and participating in the life of the organism—the homologue of the vertebrate skeleton rather than of the shell of the mollusca.

The several elements of the tests were then described, the ten columns of small plates constituting the ambulacra, the ten larger, the interambulacra, separated from each other by ten rows of holes—the poriferous zones. The tubercles with which these plates are studded were then enumerated—the large primaries, the secondaries, the minute granules, and the miliary granulation. The varities of form and arrangement of the pores were next reviewed, and then the relative position and varying shapes of the two great orifices, the receptive and rejective poles. The internal organization was briefly glanced at, and the principal viscera enumerated. The apical disc was described, its separate elements, the ovarian, and ocular plates, their relative nature and position indicated.

The varieties of spines, their forms, sculpture, attachment, and the structure of their parts, was also pointed out.

The author next proceeded to dwell upon the relative value of the external organs in classification, beginning with the position of the mouth and vent, and especially urging attention to the physiological import of these and the other organs, and even of sculptural decoration of the test as indicative of purpose and design, and not to be considered merely valuable as means of classification. He dwelt upon the necessity of taking into consideration the mutual relations of the great vital functions of digestion, reproduction, vision, and locomotion as the basis of any sound natural arrangement. The position of the vent either within or external to the elements comprising the apical disc was shown to be a good character by which to divide the order into two great divisions—the Exocyclic and the Endocyclic Echinidæ; the structure of the ambulacra and poriferous zones, taken in connection with the position of the vent, formed good secondary characters for grouping the genera into natural families, while the former were well defined by the form, number, and arrangement of the spines and tubercles, the miliary granulation, the size and number of elements of the apical disc, and the position of the vent taken collectively. The author then intimated that the limits he had assigned to himself did not permit of any indication of specific characteristics, but that he should content himself with an enumeration of the principal points of the generic classification of the Echinidæ of the chalk, and of the families to which they belonged.

He then proceeded to describe by the aid of numerous large diagrams the generic distinctions of Cidaris, Diadema, Cyphosoma, Echinus, Salenia, Discoidea, Galerites, Cacatomus, Nucleolites, Catapygus, Pyrina, Holaster, Cardiaster, Ananchytes, Micraster, Hemipneustes, Hemiaster.

A vote of thanks having been passed, the author stated that in selecting this subject he had been guided by an old admiration of an order which, from living in a chalk-district, had attracted his attention in early youth, and he had often felt the want of such a guide as the observations he had just made would furnish. He particularly denied all claim to originality, his only merit being that of having collected into one view, materials which lay scattered in a number of rare and costly works.

NOTES AND QUERIES.

THE DEPOSITION OF WARP.—DEAR SIR,—During a short visit in Yorkshire, I have had my attention again directed to the process of warping, and upon which I am anxious to submit two questions.

1st. Where does this warp come from?

That it comes from the sea is certain, because it is only carried on to the low lands at high tides. The amount of sediment brought up these rivers, especially *in dry seasons*, is very considerable. Upon one farm near Howden, I am told that a deposit of warp two feet thick has been formed by four spring-tides, which, with the intervals of neap-tides—when the land would not be flooded, would occupy about two months.

In wet seasons, when it might be expected that a larger amount of solid matter would be carried into the rivers from the higher lands, the quantity of warp deposited is far below the average, and that the greatest deposits are in dry seasons.

This warp in the Humber and its tributaries seems to be exhaustless. It has been deposited on the lands surrounding these rivers for a number of years, and it is as abundant now as ever.

The question then naturally arises, whence comes this warp? Is it the disintegrated materials from the rocks which form the abrupt coast of Yorkshire? Throughout the whole extent of this coast the sea is constantly wearing away its cliffs, corroding its promontories into fantastic forms, and hollowing its rocks into "deep and solemn caverns." At Withemsea, Hornsea, Bridlington, and many other places, there have been remarkable encroachments of the sea within a few years, to the destruction of some miles of surface-land. If this warp be the worn materials of these rocks, why do not other rivers, such as the Tees and the Tyne, deposit it on their surrounding lands?

This warp is procured on the low-lands adjoining the Humber, &c., as a substitute for manure; and the prolific crops both of cereal and roots which it produces is a sufficient proof of its fertilizing properties. The ordinary crops of wheat, for instance, average as much as six quarters to the acre, and the potatos in the London market grown on these warped lands are said to be preferred to any other.

2nd. How is it that the Humber and its tributaries—the Trent, Ouse, Don, &c., are the only rivers in Great Britain that deposit "warp"?

That there is no other river in this country which deposits solid matter such as "warp," on the low lands that may be flooded by it at high tides I am creditably informed is a fully ascertained fact. I have had but one opportunity for inquiry of a friend residing near the Mersey, who tells me, if the waters of that river were allowed to overflow the adjacent lands at high tides, which is sometimes done for the sake of irrigation, that no sediment whatever would be deposited; any deposit like the warp of the Yorkshire rivers would bury the grass to the depth of several inches, which the water was intended to invigorate.

There is another fact or two which appears to me to have a geological bearing, and which I will state as briefly as possible.

You will no doubt remember a period when the herring-fishery off Boston, at what is called Boston Deep, was the most important and extensive herring-fishery in these islands. Great Yarmouth was also justly celebrated for its mackerel, and I believe it was the custom at one time to send to the reigning sovereign of England the first fish of this species that was caught in those seas.

At the present time a herring cannot be taken in Boston deep; and if the crown of England depended on the mackerel caught at Yarmouth it would be forfeited. Is this change of habitat occasioned by any alteration in the sea-bottom, or from some change in the direction of sea-currents?

I remember when a boy to have played on the sea-shore near Boston, when it was a firm and extensive arenaceous plain at low tide. This coast is now silted up with a deposit of a similar nature to the "warp" of the Humber, and only one or two patches of the former sandy shore remains. To such an extent has the sea deposited this material in that portion of the Wash, that an enclosure of thirty-two thousand acres has been seriously spoken of. If this same condition that exists on the shore is extended over any considerable area of sea-bottom, which it is quite reasonable to suppose, it may have some connection with the departure of the herrings from those waters.

I am but an amateur geologist—young in the science but anxious to know more of those important changes which have been in constant operation on the earth's surface during a vast succession of geological periods. The above facts appear to me to have some relation to those changes both as regards fluviatile, or fluvio-marine deposits and the removal of species from a locality in which it has been formerly abundant.—Yours &c., W., Nottingham.

FOSSIL FERNS IN FRUCTIFICATION.—DEAR SIR,—I have paid considerable attention to recent ferns, both natives of the tropics and of cooler regions of the earth, and I wish now to extend my observations to the fossil species. Will you be kind enough to tell me if there are any works treating specially upon them, and which are cheap enough to be within my reach? Lyell and the other authors I possess, or can borrow, mention many genera, but seldom, if ever, give their distinguishing characteristics. We shall no doubt have descriptions of them sufficiently clear when your articles upon "The Common Fossils of the British Rocks" have advanced so far as the Carboniferous-period, but I am somewhat impatient to proceed with the study of them.

In the arrangement of the recent species the form of the frond and the venation, or arrangement of the veins, are only secondary matters; the primary characters being taken from the form, and whether they be naked or covered by an indusium. In the cabinets of my friends and the larger collections which I have seen, I have in vain sought for any specimens bearing their fructification. Lyell says they are found "for the most part destitute of fructification;" I am therefore led to imagine that fertile fronds are sometimes discovered, though rarely. Can you tell me if there are any in the public collections in London which still retain their fructification? I am extremely anxious to compare them with living forms; and by information on these points you would greatly oblige, Yours very respectfully, C. W. CROCKER, Royal Botanical Gardens, Kew.—The best authors on fossil ferns are:—Adolphe Brongniart, "Histoire des Végétaux Fossiles" Paris, 1828, 1 vol., quarto, which contains illustrations and descriptions of a large number of the known genera and species.—Lindley and Hutton, "The Fossil Flora of Great Britain," with figures and brief descriptions, London, 1831., 3 vols., octavo. Through which are scattered illustrations of many of our British fossil Filicinæ; the descriptions are extremely short. H. R. Göppert, "Systema Filicum Fossilium." (with forty-four plates) Breslaw and Bonn, 1836, quarto. The figures are very good, and many examples of fructification are given.—G. K. Sternberg, "Fersuch einer geognostisch-botanischen, Darstellung der Flora der Vorwelt." Leipsic and Prague, 1820, folio, 2 vols. The plates of this work are beautifully executed; and the descriptions, being in Latin, are more accessible to the general student than the German text.

Mantell's "Medals of Creation," vol. i., second edition, 1854, octavo, contains an outline of fossil botany, and gives some description of the genera of ferns, with cuts. This last would perhaps prove most useful, because it can be purchased for a small sum; whereas the large works alluded to above are expensive. They are in the libraries of the British Museum, the Geological Society, Somerset House, and the Geological Survey, Jermyn-street. We cannot do better than call attention to the fine collection of fossil ferns in Room I, of the North Geological Gallery in the British Museum. A great addition has just been made by the purchase of the valuable, and in many instances unique, specimens of oolitic plants from Scarborough, which formed the collection of Mr. Bean, a gentleman who has devoted very many years of his life to their accumulation. By applying to the keeper of the geological department, the student may obtain permission, as in all the other departments of our national museum, to visit the collection on private days; and every facility is afforded for the examination and comparison of specimens. The characters, so important in the classification of recent ferns being frequently absent or wanting in the fossil remains, the palæobotanist is compelled in many instances to accept the most worthless and least reliable characters, in order to form some sort of classification to guide others who may follow him in his labours.

We have seen some coal-ferns from Ilmenan (Germany) with fructification; but this condition is rare.

We must not forget to mention H. B. Geinitz's magnificent work on the Saxony coal, "Die Versteinerungen der Stein-Kohlenformation in Sachsen." folio, Leipsic, 1855, with numerous plates, as a first-rate source for information on some fossil ferns; especially as he has taken much trouble to-reduce to their true specific limits the very numerous forms of fragmentary ferns regarded by authors as typical of so many species. In the 2nd. volume of Mantell's "Wonders of Geology" 8vo., 2 vols., Bohn, London, 1858, several references to descriptions of fossil ferns will be fouud in the chapter on coal.

Mr. Gregory, of No. 4, King William-street, Strand, has recently obtained some very good specimens of *Cyclopteris Hibernica* from Ireland, in full fructification; and we believe that he has also some foreign specimens of other ferns in the same state.

Cemented Rock-debris, near Blanchard, Northumberland.—Sir,—In the November number of the "Geologist" I observe a paper on the ossiferous fissures at Oreston, near Plymouth, by W. Pengelly, F.G.S., in which the author states it as his opinion that the cavern originally communicated with the surface by an opening sufficiently wide to allow the passage of all its contents;" and that this opening had afterwards been filled up by "large angular fragments of limestone cemented by carbonate of lime, easily enough mistaken, without a careful inspection, for ordinary limestone somewhat rich in coarse veins, and which the quarrymen say is as hard as the surrounding rock."

This reminds me of a circumstance which lately came under my notice of a mass of shale-debris having become cemented in the same manner.

In working a lead mine it is customary to drive strong pieces of timber, locally called "stemples" betwixt the sides of the vein, at short distances apart. These are covered by other smaller pieces called "polings," reaching from one stemple to the other. Upon these the workmen deposit their rubbish.

In a mine at Shildon, near Blanchland, in the county of Northumberland, there is a spring of water highly charged with carbonate of lime, which having filtered for a considerable number of years through the debris consisting of shale deposited as above, has so hardened and cemented it together, that, the timber having decayed, the cemented rock not only retains its position, but it would require blasting to remove any part of it, being as the miners declare actually harder than the original bed.

This I think would support Mr. Pengelly's theory.—Yours respectfully T. Hutchinson, Waskcrley Park, near Darlington.

LANDSLIP IN THE ISLE OF SHEPPY.—SIR,—The following extract from a Kentish newspaper, dated Sept. 25, 1859, may be worth preserving in your magazine, which should be the geologist's repository for recorded facts. "An extraordinary slip of land has recently taken place at Warden-point, on the north-east end of the Isle of Sheppy, which has placed the ancient church of of that parish in great danger, as the east end of the church is only forty-one feet from the edge of the cliff. Persons residing near the church state that for three or four days previous to the slip taking place a noise was heard at very short intervals like distant thunder. Several parts of the land (pasture), with rows of large trees, hurdles, fences, and hedges, have dropped down, and the trees stand, with the hedges, hurdles, &c., perfectly upright, as though they had been moved by magic; other trees are partially inclined towards the sea, and others are quite reversed; the immense roots, the growth of many years, are turned upwards, but not a single tree is buried by the soil. A landslip of less magnitude took place about two years since, which together with the present one acted upon a space of more than ten acres of pasture land, in consequence of which the coast-guard station at this place, being considered unsafe, has recently been taken down. The land for some considerable distance south-east of the church is still opening in large chasms, varying from three inches to three feet, and in depth from three to thirty feet."—Yours &c., J. R. T.

GEOLOGY OF HARROGATE.—SIR,—I am at present staying in Harrogate, Yorkshire, and am very much at a loss as to the geology of the neighbourhood, and the best localities for finding fossils. Thinking it was possible that some of your readers might find the same difficulty, I have ventured to make the inquiry, which I hope to have answered through the medium of the "GEOLOGIST,"—Yours truly, a SUBSCRIBER and BEGINNER.—Harrogate is situated on the millstone-grit (or carboniferous sandstones of the series below the coal-measures.) These sandstones (or Yorkshire flagstones) do not yield many fossils; occasionally a few casts of stems, and some tracks of animals—referred to worms, crustaceans, fishes, &c. Fossil rain-prints are said to have been seen on some of the surfaces of the slabs. At Knaresborough, three or four miles east of Harrogate, the red rocks and magnesian limestone of the Permian series occur. This limestone is at places rich in fossils. The coal is absent there; but to the south, near Leeds, it is found in its place on the millstone-grit, and passing under the Permian rocks to the east of that town; and these in their turn disappear under the New Red sandstone, and clays of the Vale of York. About fifteen miles west of Harrogate, the lower rocks are exposed beneath the Carboniferous sandstone, namely the Yoredale slates and limestone, at Bolton Abbey, and the great "Scar" limestone is also shown at places near by, but still better to the north west in Wharfedale and Ribblesdale. In the latter valley the still lower rocks (Silurian) come to day. The geological map of Yorkshire, by Prof. J. Phillips, (sold by Monkhouse, York) should be the excursionist's companion in the wilds and valleys of Yorkshire.

SEDIMENTARY DEPOSIT OF MINERALS IN A ROCK STRATA.—SIR,—Your obliging notice of my queries respecting the sedimentary deposit of minerals, leads me to explain more clearly the views I hold respecting the origin of minerals, and their dispersion and subsequent aggregation in the various strata. Throwing aside preconceived ideas of internal heat, let us remember that our globe was probably first gaseous, then liquid, and now solid; that minerals have been condensed from the air and sea, not sublimated from beneath. When land emerges from the ocean it is saturated with all the various compounds of the sixty elements. Its elevation is, I conceive, generally speaking the superficial result of volcanic action, and an enlargement of its volume through the forces of crystallization. On its exposure to drying influences, the land becomes fissured, and its constituent parts attempt to assume an aggregate state, each metal and mineral crystallizing in veins according to the temperatures and precedence due to each; thus quartz crystallizes first, afterwards those the affinities of which bind them most strongly together, and which require longer time and lesser temperature for becoming solidified. Veins running north and south, and veins running east and west, often containing different deposits, may be accounted for by currents having overlaid each other, and made saturations of distinct kinds in any given spot; and this draws me to say that were the former forces and sources of the currents calculated, a perfect conclusion might be arrived at respecting the shape of the present continents; for no doubt the waters have deposited and shaped the lands. At first, when no land broke the surface of the globular sea, variation of temperature was the only source of its disturbance besides the tides and the motions of our planet around its axis, so that those acquainted with the laws of the winds and tides might readily surmise which had been the point where the greatest accumulation of solid matter took place in the shape of a reef or shoal, and how its first appearance above the level of the sea affected the *then* state of things. In contradistinction to received opinion, I should say the New World was the first formed, its unbroken coastline showing that the currents were not then so complicated as they are now; but if you will give me an opinion on the subject, however crude the idea may appear, it may help to elicit facts hitherto unthought of.—Your obliged correspondent, A., Belfast.

P.S. According to my theory, of course we must look on granite as having been *made from sand and sand from granite*, the bosses into which it becomes weathered showing the seams of its deposit plainly enough. The sands of Africa and of the other desert countries may lie on granite, the upper part of which is still sand unchanged by igneous agency.

PHOSPHATE OF LIME NODULES.—DEAR SIR,—In reply to Mr. Mortimer's letter addressed to you in Number 22 of the "GEOLOGIST," I am afraid I cannot answer either of his questions satisfactorily; for I am unable to say how the phosphate of lime was detected in the nodules of the Upper Green Sand at Cambridge in the first instance, although, as you justly remark, they have long been known to contain it. Some of the nodules are supposed to be coprolites, from their peculiar form, and occasionally having scales and other remains of fish, &c., embedded in them; but the majority are, I think, not considered to be organic, although they yield phosphate of lime; for I believe it is now acknowledged that this mineral occurs in rocks more extensively than was imagined, without being derived from bones. When I was at the University, now more than twenty years ago, these concretions were known to yield this phosphate; but it is only of late years that the green sand has been so extensively worked for economical purposes. I have not seen the preparation of the nodules for agricultural uses, but I believe they are ground down in a mill, and in due course, when properly prepared, may be applied as a manure in the same way as guano, lime, and bone-dust. I have not written any special paper on this subject, but in a lecture delivered last January, at the winter meeting of the Warwickshire Naturalists' Field-Club, held at the Warwick Museum, on "The History of Fossil Bone-beds," I suggested the possibility of the application of the well-known Lias "bone-bed" to this end, and I referred to the value and importance of the green sand at Cambridge, and of the Crag in Suffolk, from which such large quantities of phosphate of lime are now obtained. I heard that a notice of this appeared in the *Mark Lane Express*, where it is possible Mr. Mortimer may have seen it.—Faithfully yours, P. B. BRODIE, Vicarage, Rowington.

FOSSIL HORNS FROM BLUE CLAY, NEAR GATEHOUSE.—There was lately found in the canal leading from the Bay of Fleet to Gatehouse a pair of horns attached to a portion of the skull apparently belonging to an animal of the stag species.

They were found in a compact blue clay about twenty feet from the surface, and are in excellent preservation. These are now in my possession. Each horn has seven antlers, and the following are the dimensions—viz., length of horn three feet ten inches; length of the bottom antlers thirteen inches; width between the top of the horns three feet two inches; circumference of the horn nine inches; circumference of the bottom antlers five inches; width between the top antlers on each horn fifteen inches; width of the skull eight inches; weight of the horns twelve and a-half pounds. If either you or any of your readers can give any information respecting them or the animal to which they belonged, it will much oblige yours, &c., **Wm. Gordon**, Gatehouse.

Coal at Murree on Punjab Railway.—A few weeks ago a "Report," accompanied by a number of illustrative geological plans and sections, was forwarded to the Government from the Punjab Railway, upon the discovery of coal and iron at Duntelle and Mohara, by Mr. Calvert, C.E. and F.G.S., one of the Staff, who brought down large blocks of coal from thence. But, it is said, the mountainous character of the district, and its being within the dominion of the Maharaja of Cashmere, who asked an exhorbitant "Royalty," or tax on it, induced the company to abandon further search, although Mr. Calvert entertained opinion of a successful result.—"Lahore Chronicle," Sept. 10, 1859.

Pitted Surface of Magnesian Limestone.—Sir,—I have just returned from a visit to Roche Abbey, in this county (Yorkshire), and as I usually examine the rocks and quarries whenever I have an opportunity wherever I go, I was much surprised to find the beds in that locality, which I think are mostly magnesian limestone, marked by indentations in layers every two or three feet by what appeared to be rain-drops. I had often read of such markings in some localities, but hitherto had never met with them. I at first thought it might be the effect of crystallization, but had this been the case, it would have pervaded the whole mass of rock, whereas it was only in layers. If I am right in attributing it to rain-drops, the limestone must have been in a state of soft mud at the time, and exposed to the surface, for the markings are so deep and abundant as to form a very striking feature, and large slabs of five or ten feet square, or perhaps fifty or sixty might be had. I have frequently sought for fossils in this limestone, and almost in vain; but I felt much interest in this phenomenon. I enclose you a small piece for your inspection.—G.W., Wakefield.
—The roughly-pitted surface of the limestone alluded to is due to weathering, or to the percolation of water between layers of the rock. Many limestones and marbles exhibit surfaces more or less fretted or eaten into in this way; and the mesh-like arrangement of the cavities is perhaps due to the destructive agency of water removing some softer atoms at different spots, each of which latter becomes a centre of further chemical operations, and is separated from the neighbouring pits by less destroyed ridges.

Anthracite and Iron.—Sir,—Taking advantage of the monthly "Notes and Queries" in the "Geologist," I beg to trouble you with the two following questions.

First: In reading lately a geological work on Coal, the author, after stating its vegetable origin and describing the various kinds of coal, mentioned Anthracite, which I suppose means Cannel-coal, and stated that Anthracite was black-coal buried deeper in the earth, was more mineralized, and, in consequence of its contiguity to some volcanic rock, had lost its pitch. If this be the origin of Cannel-coal it does not seem to solve my question; for here we have, at one hundred and twenty yards from the surface a bed of two feet of good "house-coal, eighteen-inches of dirt, then a foot of "engine-coal;" forty yards higher a bed of good "house-coal" twenty-six inches thick; twelve yards higher "engine-coal," eighteen inches thick; dirt six inches; "drossy"-coal three inches; good Cannel-coal thirteen inches. There is no appearance of a volcanic rock anywhere near. How then can we reconcile the two?

Second: Is Iron of vegetable-origin, as Hugh Miller seems to give the idea in his transmigration of iron in his Old Red sandstone; or of what origin is it? Troubling you so far, I remain, Yours truly, A New Subscriber, Dewsbury. —First: Anthracite not being the same as cannel-coal, the first question falls to the ground.

Coal that has lost its hydrogen, whether on account of the proximity of igneous rocks, or from other causes, is Anthracite (stone-coal, culm, steam-coal, &c). Cannel-coal has usually more earthy and animal matter in it than common coal has; and has probably resulted from the compressed peaty mud, often full of fishes, formed in the carboniferous lagoons.

Second: Iron-ores are frequently associated with coal and other fossil vegetable matter, and some of the iron may probably have been once in the form of bog-iron, which is said to consist of ferruginous infusoria; or it may have once been to some extent contained in the wood, stems, and leaves. At all events it appears that in the decomposition of the vegetable matter, carbonic acid would be formed, and this would unite with the oxide of iron, which is so universally distributed in earths, muds, gravels, &c., and would form a carbonate of iron. This would often become aggregated into masses in the silt or clay-beds, and form the ironstone-nodules of the coal-measures. But the mass of the oxides, the carbonates, and other salts of iron found in the rocks has probably been converted and reconverted again and again, now in one stratum of deposit now in another, now in a trap rock now in a granite, now on the surface, and perhaps in some organic body, now deep down in a mineral-vein; and, after passing through successive changes of combination, are still suffering alterations within the natural limits of chemical affinity, and subject to the many mechanical agencies that are liable to remove them from one place and rearrange them in another.

REVIEWS.

Beach Rambles in search of Sea-side Pebbles and Crystals, with some Observations on the Origin of the Diamond and other precious Stones. By J. G. Francis. London: Routledge, Warne, and Routledge. 1859.

When people with good reputations indorse the paper of other people who have no reputation at all, they must take the consequences. All the world knows as well as we do the many good books the Messrs. Routledge have produced: their names alone to a book are sufficient to, and do, sell it; and they must, therefore, submit to the strictures and commentaries that hundreds of others besides ourselves will make on such a pretentious volume—one of the poorest in zoological, geological, mineralogical, and chemical knowledge it was ever our misfortune to be under the obligation of reading. We have the greatest personal respect for those gentlemen, and gratefully remember the many hours of amusement and instruction their works have afforded us, the cheap rates at which many valuable publications have issued from their hands, and the important modifications made by their efforts in the general book-trade. They must forgive our remarks, however severe they may be, in doing that duty which, as long as we exist as a popular exponent of a popular and grand ce, we shall fearlessly do, of defending its sacred domains from the intrusion of any kind of trash. We do not want to pull Mr. Francis's book altogether to pieces, for some passages are nicely written; but we can not stand by to see some thousands of people thirsting for knowledge and drinking in innocence from such an unwholesome stream.

We have read the book only half through—we confess it: we could not get any further. To do as much as this even we pulled up several times. We managed to get at the first stage over sixteen pages. When we opened the book we anticipated better things. "I know," it begins, "of few things more pleasant than to ramble for a mile along one of our southern beaches in the early days of autumn. We get the sniff of the sea-breeze; we see prismatic colours dappling the water, or curiously reflected from capes of wet sand; solemn beetling cliffs, broken here and there by a green slope, rise on one side of us; while on the other, we are enchanted by the wild music of the waves, as they dash noisily upon the shingle at our feet, and then trickle back with faint lisping murmurs into the azure gulf."

At the third page, however, we tripped a little over a confusion of "agates," "fossils," "pebbles," and "pebbly-beaches." As we progressed onwards we had sundry little slips over "quartz-agate" (p. 13), "ribs of a conglomerate" (p. 13), "tubular arms branching out from one central trunk" of a choanite, and many like absurdities. We were fairly taken aghast at page sixteen by the "limestone tubes" and gelatinous substance of the interspace between them attributed to that sponge; this gelatinous substance is described as "still retaining that appearance in a medium of semi-pellucid chalcedony," whereas in reality the so-called gelatinous substance was once sponge-tissue, since lost in the process of mineralization. We read on. "By the side of the choanite is another fossil which we now call an 'alcyonite', the learned name of the nearest living species being 'alcyonium digitatum.' It is well known in the Isle of Wight as 'dead man's fingers.'" And what, indeed, do these petrified "dead-man's fingers" prove to be? The wood-cut solves the mystery, the artist has drawn what he has seen, and the fossil is really the roots of a cretaceous sponge turned *upside down!*

At the next page our author speaks of "a zoophyte not *injected* as are the choanites, but preserved bodily in gray flint. It is an undoubted 'actinia,' in every respect the same as those pulpy individuals who are displaying their jelly-like bodies and floral hues in many a household aquarium. This creature once floated up and down in shallow marine pools, or clung to banks of ribbon-weed fringing the coast-skerries. At present, himself of stone, he is firmly wedged in a hollow within a large pebble, and reminds us of the words of a pretty song—

'I dreamt I dwelt in marble halls.'"

We put the book down. We had been brought to a full stop. This was too bad. We need scarcely say the fossil he was thus describing was a choanite. No regard is paid to the alliances of the sponges, choanites, and ventriculites at all. Mr. Toulmin Smith would reject the assertion that the ventriculites must have been creatures lower down in the scale than the choanite, and Dr. Mantell would have been disgusted to have been told that living ventriculites "resembled in stature and configuration an ordinary toad-stool." Indeed, the name "ventriculite," if the author knew its meaning, might have saved him from such an exposure of his ignorance. Verily he seems to know nothing correct of the nature of the choanite, nor of the other fossils he figures or describes, but to be entirely misled by fanciful similitudes. His "vermicular," fossils, his "asterid," his "nondescript," his "myriapod," his "terebratula," are as gross instances of ignorance as anybody with a B.A. after his name could invent. In the "myriapod" of plate v. we have merely a choanite cut through obliquely; and not to weary the reader with too numerous selections of such palpable fancies, we restrain ourselves to the notice of one other—plate vii., fig. 2. Let us quote the description of this "Fig. 2.—'Terebratula': The entire pebble was formed inside of a 'pecten'-shell, and *inside the pebble* lies this formation, which was a living organism connected with the hinge."

Can a more magnificent jumble of absurdities be penned? This specimen, as we see by the plate, is an ordinary moss-agate, from which the structure of a choanite has disappeared under the effect of mineralization, and to the uneducated eye of the author, dreaming of likenesses instead of tracing out nature, has appeared to bear a vague resemblance to a shell which he has termed, of all things under the sun, a terebratula.

Neither can we avoid commenting here on the author's very evident want of knowledge of the different characters and conditions presented by the substance of which the objects he pretends to describe are composed, otherwise we should not find him speaking of "quartz-agate," "agatine-siliceous," &c. His knowledge of mineralogy might surely have been sufficiently improved by a reference to any popular handbook to have saved him from an exposure of his ignorance of the distinctive characteristics of flint, chert, chalcedony, agate, carnelian, and quartz. The "silicified parti-coloured madrepore" spoken of at p. 62, and the pebbles "chafed and worn to skeletons" on the Bognor shore (p. 62), must be curiosities indeed worth preserving.

After our pause at page 17, by an effort we did resume our reading, hoping to find some redeeming qualities for such sad errors. At page 18 are some figures of fossils, amongst them one of the most abundant from the white chalk, which formerly was called *Spatangus*, and of late years *Micraster cor-anguinum*. The prefix to the wood-cut of this is merely *cor-anguinum*. Was the author in doubt which generic cognomen to take, or can not it be possible he could be ignorant of the proper name of so common an object?

With the practical directions contained in the account of "the lapidary's workshop" we were certainly pleased, and regard it as the best written portion of the work.

The chapter on the contents of a good beach might have been deemed good also, had it been correct; but when we hint that the author supposes the presence of bitumen in chalk-flints—that he throws his refuse chalcedony-pebbles "into the sea, there to undergo a fresh impregnation"—a strange notion which is repeated at page 65, where he refers to the effects produced by the "crystallizing waves"—we shall have done quite enough to expose the shallowness of his mineralogical acquirements.

Those who read (?) the work will find he employs his mother tongue in a very loose manner indeed, as this sentence from page 5 will exemplify. "But what have I got? Above thirty globes of chalcedony, blue and white, as oval as bantams' eggs." Although a book upon "pebbles," he rarely if ever uses that word even with its proper meaning, for he confines it merely to denote more or less transparent and parti-coloured siliceous stones. The natural history knowledge displayed is no better than that shown of other departments of science. At page 41, the choanite—a bulbous sponge—is described as "undoubtedly a beautiful creature," and at page 42 as possessing "feelers." At page 42, too, that there might be no mistake about that absurdity, the unfortunate "actinia" is again alluded to as being "of the 'crass' kind" with "tubular tentacles." We puzzled ourselves at first what the "crass" kind of actinia were. Our knowledge of the objects of the sea-shore is not slight: after five-and-twenty years residence on the coast, we were tolerably familiar with most of the "sea-anemones," and yet we did not know the "crass" kind. At last a light struck in upon our reveries, and we suspected "crass" was a slang contraction of "crassicornis." We do not like slang, and there is far too much of "fast" language in the book; but vulgarity of vulgarities, to talk about tobacco-smoking.

His geological statements are equally valueless, as witness at page 5 his remarks about "veins of porphyry and serpentine in the trap and basalt;" those at page 44 about "the extinct volcanic agency" that had made "red, yellow, and green jasper-flints" out of "burnt flints" from the chalk; and others of the like sort too numerous to mention.

Although his notions about kaolin, sapphires, the age of granite, and the relations of clay and feldspar, and on many other subjects may be vague and ridiculous enough, he sometimes shows out in his better self, and presents us with passages which by themselves might be regarded almost as beautiful. One of these in reference to gems we pick out as well worthy of a better book. "As to our own sea-girt isle, it is surely as guiltless of indigenous gems as of white elephants or birds of paradise. Had any such existed with us, they must long ere this have been brought to light and appeared in the market. We have bored the plain to two hundred fathoms depth; we have pierced the hill-side in tunnels which extend for miles; geologists and antiquarians have delved, and hammered, and sifted; many curious fossils have turned up, and a world's wealth in minerals, but never anything like a diamond or oriental.

"It is well that to console us under such apparent poverty as to the gems, we possess the treasure an hundred-fold in other shapes, though derived from the same sources. Clay gives us no sapphires; but it floors our ponds and canals, furnishes our earthenware, and yields the bricks which have built the ribs of London. Carbon refuses to flash upon us in the rays of an indigenous "brilliant," but it feeds our furnaces, propels our steamers and locomotives, and cheers a million of household hearths under the well-known form of coal. And iron is our national sceptre; it reddens here no jacinth or ruby; but it supplies us with spades and ploughshares, lays down thousands of miles of railway, and has made England the forge and workshop of the known world for giant engines and massive machinery.

"If our earth be less dazzling than that from Golconda or Peru, it is, we may hope, more durable, flowing to us through a healthier channel, by the honest labour and steady perseverance of the sons of the soil."

We have admitted that we have read only half the book; we have, however, skimmed over the rest, hoping sincerely to find some redeeming parts; but, alas! we have only found it worse and worse.

Here and there, as we have already said, there are pretty bits of writing; but as neither gold nor silver, however beautifully elaborated by human art, redeems the treacherous mock jewel within the setting, so such attractive passages only gild with a showy film the rottenness of the work within.

Handbook of Geological Terms and Geology. By DAVID PAGE, F.G.S. London and Edinburgh: Blackwood and Sons, 1859.

This is a valuable book that has long been wanted by professional geologists and amateurs. The "General Terms and Technicalities" (pages 55—381) are carefully elaborated. The derivations are correctly given; the explanations are full and suggestive. The right pronunciation of the terms is indicated by proper accentuation.

The list of "Specific Appellations" (pages 385—416) will be a boon to many a student, who can hereby make himself acquainted with their meaning and pronounce them correctly, though unacquainted with Latin and Greek.

The "Tabular Schemes of the Chemical, Mineral, Lithological, and Vital aspects of the Globe" (pages 11—51) form a skeleton of geological knowledge.

Elementary substances, minerals, plants, and animals of all grades are here carefully classified; and the geologic series of phenomena are tabulated with the latest corrections.

We fully coincide with the author in his prefatory remarks, that such a handbook as this is greatly needed; that technicalities must exist in a new science, to express new objects and new facts; that in this book the ordinary reader referring to it will generally find the information he requires in the first and second sentences of a definition; and that the student, the miner, the engineer, the architect, the agriculturist, and others, will find much that is useful to them in the longer descriptions and explanations.

The book is well printed, with good clear type, and is remarkably free from errors: an advantage doubtless arising from the fact that the work is from the hands of an author who knows his subject, takes a pleasure in it, and conscientiously bestows upon it plenty of time. We hope he will soon have occasion to produce a second and enlarged edition.

Elementary Geological Collections; and Geological and Entomological Cabinets. Issued by the NATURALISTS' ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, 17, Dean-street, Soho, London.

No. 47.—Small box with lifting trays containing a collection of ninety specimens of minerals classified and arranged according to their chemical bases.

No. 48.—The like collection bound in two volumes.

No. 15.—Geological Collection of Rocks and Fossils, containing about 120 specimens illustrative of the Palæozoic, Mesozoic, Cainozoic, the Igneous and Volcanic rocks.

Cabinet No. 10.—Containing six drawers for Entomological, Geological, or other collections.

We inspected these cabinets and the selections of minerals, rocks, and fossils with much pleasure, because pains have been taken to get them up tastefully, cheaply, and well. The specimens of even the smaller elementary collections are sufficiently large to display the general characters of the objects. The geological collection of rocks, No. 15, is formed of pieces almost large enough to be termed hand-specimens; while the common typical fossils with which these are interspersed give additional value and interest to the series.

The small cabinet, No. 10, is a very tasteful affair. The door and the drawers being veneered, it presents quite a drawing-room appearance. It is well adapted for small collections of insects, or very select fossils, and is one of a series of cheap cabinets, which will supply a long-desired want amongst amateur naturalists.

In one instance, in No. 48, we detected two wrong minerals; but this is apparently only a misplacement in their respective spaces of Oxide of Manganese and Oligist Iron, as in the same collection bound in book-like cases, these minerals are correctly placed. In the list of strata the granite and some other rocks are (contrary to some classifications) very properly and correctly grouped together with the intrusive rocks.

Altogether these selections are very creditable and very fairly reliable.

END OF VOL. II.

INDEX.

A

Aërolites, Minerals in, 84
Aërolite, large recent, 257
Algæ, Parasitic, in shells, 328
Alum, Formation of, 34
Anderson, Rev. Dr., On Tilestones of Forfarshire, 149
————, On Dura Den, 291
————, Monograph of Dura Den reviewed, 456
Anglesite, Crystalline forms of, 84
Animal Kingdom, Grouping of, by S. J. Mackie, 346
Anonymous Communications, 42
Ansted, D. T., on Slickensides, 484
Anthracite of South Wales, Dr. Bevan on, 75
Anthracite, Note on, 495
Arsenic in Lignite, 120
Austen, R. A. Godwin, "Natural History of European Seas" reviewed, 453
Australia, Southern, Geology of, Selwyn on, 292
Aveyron, Burning Coal Pits of, 34

B

Beach Rambles in search of Sea-side Pebbles, reviewed, 496
Beadnell, Geology of, Mr. Tate, on, 59
Beaver, First British fossil, 409
Biaritz, Earthquake at, 33
Binney, E. W., On Lias near Carlisle, 165
Bottom Rocks, S. J. Mackie, on, 153, 181
Bourgueticrinus, Mr. Wetherell, on some stem-plates of, 449
Brachiopoda, Carboniferous, of Scotland, T. Davidson on, 461
Brachiopoda, Palæontological Notes on, by T. Davidson, F.G.S., 97
British Association Meeting, 397, 434, 482
British Shells, Illustrated Index of, by G. B. Sowerby, reviewed, 332

C

Cabinets, cheap, noticed, 500
Cabinets for Fossils, Cheap, 329
Canada, Geological Survey of—Report of progress for 1857, reviewed, 372
Canoes, Ancient, 371
Catalogue of British Fossils, by Prof. J. Tennant, reviewed, 90
Caucasian Geology, Notes on, 92
Cement for Chalk Fossils, 215
Cemented Rock-debris, near Blanchard, 492
Cephalaspis asterolepis, Mr. J. Harley, on, 95
Chalk Strata around Wealden Area, Thickness of, 215
Chemical Geology, Some Points in, T. Sterry Hunt, on, 93
Chitonidæ, Permian, J. W. Kirkby, on, 167
Clarke, Dr. Hyde, On the utility of Local Geological Surveys, 169
Clinometers, Forms of, and manufacturers of, 220
Coal, Artificial formation of, 161
——, Crystalline, 161
—— that cuts Glass, 163
—— at Tete, South Africa, R. Thornton on, 166
——, Vegetable Structures in, Dr. Dawson on, 167
—— near Worksop, Notts, Messrs. J. Lancaster and Wright on, 292
—— at Murree, on Punjab Railway, 495
Colonists, Communications from, 37
Common Fossils of the British Rocks, S. J. Mackie on, 153, 181, 341, 381, 421
Cone-in-Cone Structure, H. C. Sorby on, 485
Copper Smelting, Dr. Hyde Clarke on, reviewed, 180
Cotteswold Naturalists' Field-Club, 172
Crackers, and other Fossiliferous Nodules, 91
Cretaceous Rocks of Norfolk and Suffolk, 372

Cretaceous Beds of Limbourg, Sketch of, by Binkhorst, reviewed, 417
——— Strata of Maestricht, 419
Crocodilus Hastingsiæ, Dermal Armour of, Huxley on, 209
Crystals, Optical Properties of, Descloizeaux on, 206

D

Davidson, T., Palæontological Notes on Brachiopoda—No. 2, Strophomenidæ and Productidæ, 97
Davidson, T., the Carboniferous System in Scotland characterized by its Brachiopoda, 461
———, On Spirifera convoluta, 313
Daubree, Prof., Researches on Metamorphism, 121
Dawson, Dr., On Fossil Plants of Devonian Rocks of Canada, 93
———, On Vegetable Structures in Coal, 167
Dendritic Markings, 217
Devonian Rocks of Canada, Fossil Plants of, Dr. Dawson on, 93
Diagrams, Elementary Geological, published by Mr. J. Reynolds, reviewed, 90
Dicynodon Murrayi, Huxley on, 166
Drift Deposits, Age of, 173
—— Clay at Leicester, Blocks of Oolite in, 176
Dundry Hill, Note on, by Mr. R. Etheridge, 209
Dura Den, Yellow Sandstone and Fossil Fishes of, Dr. Anderson on, 41, 291
———, Monograph on, by Rev. Dr. Anderson, reviewed, 456

E

Earth and the Word, The, reviewed, 128
Earthquakes in Turkey, 87
——— at Pavia, 205
———, Supposed Relations between, and Phases of the Moon, 205
Elementary Geological Collections noticed, 500
Encrinites and Crinoids, Note on, 299
Erratic Phenomena in Hungary, On some, by Prof. Suess, 288

F

Falconer, Dr., On the Grotta di Maccagnone, 289
Fish, Shoal of, buried in Sand, 216
Flints, Banded, 404
——— of High Port, Mark Norman on, 297
———, Small Nodular Concretions in, N. T. Wetherell on, 193
Ferns Fossil, in fructification, 491
Footprints in Old Red Sandstone at Cummingstone, Beckles on, 48
Foreign Correspondence, by Dr. T. Phipson, 32, 80, 120, 161, 205, 257, 279, 477
———, by Count Marschall, 278, 328, 477
Forfarshire, Flagstones of, Hugh Mitchell on, 147
———, Tilestones of, Dr. Anderson on, 149
Fossils, Collecting from Workmen, 410
———, Localities for, around London, 173
Frogs, Live, 42
—— in Stone and in Trees, 299
——, Respiration of, 330

G

Gems from Private Collections, 160, 313
Geological Chart, by Prof. J. Morris, reviewed, 180
——— Excursions, 217
——— Inferences, Observations on, by Mr. J. A. Davies, 404
——— Map of Central Europe, by Von H. Bach, reviewed, 300
——— Pearls, G. B. Rose on, 295
Geological Society of London, 43, 93, 124, 165, 207, 289, 486
——— Topography, 215
Geologists' Association. 39, 48, 95, 169, 214, 488
———, Summer Meetings of, Suggested, 329
———, Field Meetings of, 368
Geology, Class Lectures on, 411
Gibb, Dr. G. D., On Fossil Lightning, 195
Girvan, Ayrshire, Fossils from, 412
Glacial Action in Wales, 127
Gloag, Paton J., Rev., The Primeval World by, reviewed, 128
Gold Field of Ballaarat, H. Rosales on, 95
Gower, A Week's Walk in, by Dr. Bevan, reviewed, 332
Granite, Weathering of, T. Rupert Jones on the, 301
———, Non-protrusion of Solid, 415

Grotta di Maccagnone, Dr. Falconer on, 289
Gypsum and Dolomite, Formation of, T. Sterry Hunt on the, 293

H

Handbook of Geological Terms and Geology, by D. Page, reviewed, 499
Harrogate, Geology of, 493
Hæmatite, Deposits of, Glamorganshire, Dr. Watson on, 241
Harkness, Prof. R., On Geology of Hook Point, 28
Hautes Alpes, Physical Geography of, 281
Hereford, Map of, by E. Curley, reviewed, 340
Highlands, Northern, of Scotland, Mr. J. Miller on, 44
————————, Sir. R. Murchison on, 45
Hook Point, Geology of, Prof. R. Harkness on, 28, 71

Hunt, T. Sterry, On Chemical Geology, 93
Huxley, Prof., On Dicynodon Murrayi, 166
————, On Amphibian and Reptilian Remains from South Africa and Australia, 207
————, On a Fossil Bird and a Fossil Cetacean from New Zealand, 209
————, On Rhamphorhynchus Bucklandi, 208

I

Icthyosaurus platyodon in York Museum, 218
Iguanodon Remains at Atherfield, Isle of Wight, 41
Inferences, Geological, J. E. Davies on, 449
Initials, Protest against the Use of, by correspondents, 38
Iron, Notes on, 495

J

Jurassic Flora, Baron de Zigno on, 289

K

Kaolin, French, 35

L

Landslip in the Isle of Portland, 127
————in Isle of Sheppy, 493
Lavas formed on Steep Slopes, Sir C. Lyell on, 315
Leckenby, Mr. J., On Speeton Clay of Yorkshire, 9
Lectures on Geology, 411
Liassic Deposits near Carlisle, E. W. Binney on, 165
Lightning, Fossil, Dr. Gibb on, 195
Lingula Flags or Primordial Zone, Foreign Fossils of, J. W. Salter on, 165
————————, S. J. Mackie on, 421
Lisbon, Earthquake at, 32
Lizard, Live, in a Seam of Coal, 410
Local Museums, 177
Loftus, W. Kennett, Obituary Notice of, 176
London Clay, Fossils from, 415
Lyell, Sir C., On Lavas formed on Steep Slopes, 315

M

Mackie, S. J., On Common Fossils of British Rocks, 153, 181, 341, 381, 421
Malvern, Guide to the Geological Localities of, 218
————, Natural History Field-club, 170
Mammalia, Fossil, of the Vienna Tertiary Strata, 287
————, Oldest Fossil, 122
Mammalian Remains near Wells, 40
———————— at King's Lynn and Chatteris, 92
———————— in the Dover Museum, 127
———————— in the Valley of the Soar, Leicestershire, 174
———————— at Barton, Petworth, &c., in Sussex, 219
———————— near Mendip, Wales, 220
———————— in Essex, Norfolk, Northamptonshire, and Durham, 220
———————— at Brockhall and Stutton, 452
———————— Supposed Triassic, Mr. C. Moore on, 173
————————at Gatehouse, 494
Man, First traces of, on the Earth 432 479

Manure, Mineral, in the Greensand, 414
Map, Geological, of England and Wales, by Prof. Ramsay, reviewed, 135
Marcou, M. Jules, On Neocomian and Wealden Rocks in the Jura and in England, 1
Marschall, Count, 278, 283, 285, 328
Mastodon Remains in Canada, 217
Megaceros, First Fossil, 177
Metalliferous Strata of Rochlitz, 283
Metamorphism by Granite Rocks, Delesse on, 206
——— undergone by Eruptive Rocks, Delesse on, 281
Metamorphic Rocks, Notes on, by J. A. Davies, 451
Meteoric Stones, 85
———, Coal and Carburetted Hydrogen in, 161, 278
Meteorites, Notices of, by Hörnes, Wöhler, and Haidinger, 285
Miller, Mr. John, On the Succession of Rocks in the Northern Highlands, 44
Mineral Kingdom, The, by Dr. J. G. Kurr, reviewed, 178
Mineralogy, Lecture on, by Prof. Tennant, 169
Minerals, Rock-forming, Descriptive List of, 231
Minerals, Sedimentary Deposit of, in Rock Strata, 493
Mineral Springs of Goritzia and Istria, 284
Mineral Veins in Limestones and Sandstones, 40
———, H. C. Sorby's Note on, 40
———, Formation of, by Sedimentary Deposit, 416
Mitchell, Hugh, On the Flagstones of Forfarshire, 147
Morayshire, Sandstones of, Sir R. Murchison on, 45
Mosaic Narrative, Third and Fourth Days of, 410
Murchison, Sir R. I., On the Geological Structure of the North of Scotland, and the Orkney and Shetland Islands, 43
———, On the Geological Structure of the North of Scotland, 45
———'s Siluria, reviewed, 88

N

Napoli and Palmieri, New Minerals described by, 280
Natural History of the European Seas, by Forbes and Austen, reviewed, 453.
Neocomian and Wealden Rocks in the Jura and in England, M. Jules Marcou, 1
Nodules, Artificial, 412
Noises, Subterranean, 83
Notes and Queries, 37, 91, 127, 173, 215, 295, 329, 368, 404, 445, 490

O

Oldhamia, The Discoverer of, 371
Old Red Sandstone, Crustaceans of, 42
———, Fishes of, Egerton on, 290
Oolite of South of England and of Yorkshire Coast, Dr. Wright on, 209
Oreston, Ossiferous Fissure at, W. Pengelly on, 434
Ore-Veins, Formation of, H. C. Salmon on the, 355, 389, 427
Organic Life, Tabular View of Divisions of, by S. J. Mackie, 344
Oxford, Strata, Phillips on, 290

P

Page, D., Advanced Text Book of Geology, reviewed, 332
Page, D., Handbook of Geological Terms and Geology, reviewed, 499
Palæontological Society, 414
Palæontology, The Archæology of, 176
Paradoxides novo-repertus, 165
Pattison, S. R., The Earth and the Word, reviewed, 128
Peaks, Passes, and Glaciers, reviewed, 336
Pengelly, W., On Ossiferous Fissure at Oreston, 434
Pentacrinite Plates, Movements of, in Vinegar, 218
Persia, Minerals from, C. A. Murray on, 166
Price, J., on Slickensides, 482
Phacops caudatus, from Dudley, 160
Phipson, Dr., Foreign Correspondence by, 161, 205, 257, 278
Phosphate of Lime Nodules, Notes on, by Rev. P. B. Brodie, 494
Pitted Surface of Magnesian Limestone, 495
Platina, Native, 328
Pleistocene Deposit at Cambridge, Shells in, 215
Pre-Adamite Ages, J. A. Davies, note on, 451
Primeval World, The, reviewed, 128
Proceedings of Societies, 43, 93, 124, 165, 207, 289, 486

Productidæ, Davidson on, 97
Purbeck Dirt-bed, Original thickness of, 216
——— Geologic Scenery of, by P. Brannon, reviewed, 133

R

Ramsay, Prof., Geological Map of England and Wales, reviewed, 135
Red Chalk of England, Rev. T. Wiltshire on, 261
Red Sandstone of Herefordshire, Fossils from, Rev. W. S. Symonds on, 485
———, List of Fossils from, 275
———, Note of Fossils from, 417
Reptilian Eggs, Supposed, from Great Oolite, Buckman on, 290
——— Remains from South Africa, Owen on, 211
Reviews, 88, 128, 178, 300, 332, 372, 417, 496
Rhamphoryhynchus Bucklandi, Huxley on, 208
Roberts, Mr. G. E., On Upper Ludlow Tilestones, 117
Rock Basins, Artificial Origin of, 368
—— Formations, Contemporaneity of, 415
——, Suggestions respecting, 452
——, H. C. Salmon on, 221
——, their Chemical and Mineral Composition, H. C. Salmon on, 49
——, Chemical Symbols of Elements of, 52
——, Constituents of, 55
——, List of Elements and Primary Compounds, 53

S

Salmon, H. C., On the Formation of Ore-Veins, 355, 389, 427
———, On Rocks, 41, 221
Salt-basins of l'Hérault, 35
Salter, J. W., On Foreign Fossils of Lingula Flags, 165
Sand-hills of the Mediterranean and of the Coast of Flanders, 81
Sand-pipes near Swainstone, Isle of Wight, 175
Saurian, new fossil, 124
Scilly Isles, Geology of, Rev. Francis Stratham on, 12
Scotland, North of, Murchison on, 43
Scrope, G. Poulett, On Volcanic Cones and Craters, 124
Secondary Rocks, Lower, South-easterly Attenuation of, Mr. Edward Hull on, 213
Selenite, Films of, 175
———, Manner of cutting Films of, 40
Selenium and Tellurium at Vesuvius, 279
Shap District, Geology of, 92
Siluria, by Sir R. I. Murchison, review of, 88
———, Count D'Archiac's, Notice of, 330
Silurian Strata of Brittany, Supposed Vertebrate Remains in, 36
——— Rocks, Lower, S. J. Mackie on, 341, 381
——— Strata, Numerical Table of Fauna and Flora of, 331
Slickensides, J. Price on, 482
——— Dr. T. Ansted on, 484
Smith, Toulmin, Inaugural Address to Geologists' Association, 95
Sorby, H. C., on Cone-in-Cone Structure, 485
Sorby, H. C., On Structures produced by Currents in Stratified Rocks, 137
Sowerby, G. B., Illustrated Index of British Shells, reviewed, 332
Speeton Clay of Yorkshire, Mr. J. Leckenby on, 9
Spiders, Live, in Flints, 299
Spirifera convoluta, Davidson on, 313
Spirit of Good Books, 315
Spitzbergen, Notes on, by M. J. Lamont, 293
Sponges, Chalk, of Yorkshire, 40
——— in Chalk of Yorkshire, 409
Stagonolepis Robertsonii, Huxley on, 46
——— of Elgin, Murchison on, 164
Statham, Rev. F., On Geology of the Scilly Isles, 12
Strophomenidæ, Davidson on, 97
Structures Produced by Currents in Stratified Rocks, Sorby on, 137
Subterranean Noises, 122
Succession of Life, First Traces of, Mackie on, 341, 381
Sulphuriferous Strata in Roman States, 284
Symonds, Rev. W. S., on Fishes and Tracks from the Passage Rocks and Lower Red Sandstone of Herefordshire, 485
Symonds, Rev. W. S., On the Malvern Strata, 170

"GEOLOGY, IN THE MAGNITUDE AND SUBLIMITY OF THE OBJECTS OF WHICH IT TREATS, UNDOUBTEDLY RANKS IN THE SCALE OF THE SCIENCES NEXT TO ASTRONOMY."—*Herschel: Discourse on Study of Natural Philosophy.*

BRANNER
GEOL. LIB.

Stanford University Libraries
3 6105 008 136 207

LOCKED STACKS

Stanford University Libraries
Stanford, California

Return this book on or before date due.

[redacted] CIRCULATE